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March 15, 1961

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NUCLEAR SCIENCE ABSTRACTS

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GENERAL AND MISCELLANEOUS

4799 (AD-242653) PROTECTIVE CONSTRUCTION. AN ASTIA REPORT BIBLIOGRAPHY. (Armed Services Technical Information Agency, Arlington, Va.). Nov. 1960. 85p.

This bibliography contains about 300 report references related to construction or hardening of strategic military facilities to resist either nuclear or conventional explosives. References are limited to unclassified reports without specific limitations. Entries include references to reports pertaining to characteristics of nuclear explosions, propagation of shock waves, underground explosions, soil mechanics, and response of structures to blast. The classified portion of the bibliography appears separately as AD-318841. (J.R.D.)

4800 (CF-60-5-58) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MAY 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Aug. 8, 1960. 77p. OTS.

The studies of compaction of ThO_2 for Fuel Cycle Development have included the successful vibratory compaction of chemically densified ThO_2, high speed movies of the compacting process, the determination of the temperature gradient during compaction, and the comparison of electronic and pneumatic vibrators. Tests with a simulated HRT multiclone gave apparent underflow ratios from 3 to 4 times the values characteristic of single hydroclones. The particle size of thorium dioxide produced by flame denitration seems to increase with decreases in the reflector temperatures. Correlation of data on the oxidation of hydrogen by copper oxide in helium carrier gas was completed. A new contactor that is capable of handling small ion exchange resin samples in a flowing solution phase with well-defined hydrodynamic conditions was constructed and tested. A reasonably good linear correlation of the dissolution rates of ThO_2–UO_2 pellets in Thorex solutions was developed. Unirradiated fuel slugs were easily discharged from the expanded jackets of simulated SRE fuel elements by hydraulic pressures of ~100 psig. An acid Thorex flowsheet for recovery of uranium and thorium from Consolidated Edison type fuels was successfully demonstrated in a three column cascade, and a reflux flowsheet involving the withdrawal of the uranium strip product as a reflux point between the partition and strip columns appeared promising. First results are reported on a series of tests designed to separate the effects of the dissolution variables in the molten salt-HF dissolution of zirconium matrix fuel elements. A waste calcination experiment was carried out with simulated Purex waste starting with the calciner full of boiling water. (For preceding period see CF-60-4-37.) (auth)

4801 (CF-60-6-11) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT FOR JUNE 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Oct. 25, 1960. 96p. OTS.

A literature review is presented on mass transfer between two liquid phases. Vibratory compaction has been shown to be an acceptable method for fabricating fuel elements up to 85% theoretical power density. A correlation of data on the oxidation of carbon monoxide by copper oxide in helium was completed. The apparent induced underflow ratios for two multiclone units were 2.5 to 5.0 times the experimental and calculated values for single hydroclones of the same dimensions. The anion exchange uranium self-diffusion coefficients were measured at several velocities using the submerged pump contactor and 1200 μ Dowex 21K resin. The instantaneous dissolution rates of UO_2–ThO_2 pellets in Thorex dissolvents distributed normally at both zero and 50% dissolution. The spread was higher for the 50% dissolved sample. The Sulfex dissolution rate appears to be independent of stainless-steel loading. A 150-gal batch of solution was found to be essentially mixed in 6 min of air sparging in a packed tank. The dissolution rate of UO_2 in nitric acid is found to be a property of the source of the pellet. Pellets from the Davison Chemical Co. were found to dissolve at about 25% the rate of dissolution of PWR reject pellets. The dissolution of zirconium metal in molten fluoride baths is strongly influenced by the concentration of zirconium fluoride and only slightly affected by temperature. A waste calcination run using simulated Purex waste in a 6-in.-diameter vessel tended to confirm the radial deposition model and the fact that density and thermal conductivity of the solids are not affected by different pot diameters. (For preceding period see CF-60-5-58.) (auth)

4802 (LA-1664 and LA-1665) HEIGHT OF BURST FOR ATOMIC BOMBS, 1954. PART I. THE FREE-AIR CURVE. PART II. THEORY OF SURFACE EFFECTS. F. B. Porzel. May 1954. Decl. Sept. 1, 1960. (Pt. I(LA-1664), 140p.; Pt. II(LA-1665), 149p.). OTS.

These two reports were issued separately, but are cataloged as a unit.

This paper is issued in two volumes: LA-1664 and LA 1665. In LA-1664 the fundamental properties of a shock in free air are described, including the reasons for failure of similarity scaling. The results of an analytic solution for strong shocks are presented, which permit a determination of the energy in a shock wave from its rate of growth without recourse to similarity assumptions; from it the scaling laws for both homogeneous and inhomogeneous atmospheres are explicitly shown. The total energy is evaluated in a machine calculation for the blast wave and from this evaluation, the free air wave form for all hydrodynamic varia-

bles is presented. The general nature of the laws governing thermal radiation from atomic bombs is deduced, a new figure of merit for thermal radiation is suggested to replace the concepts of "thermal energy" and "critical calories," which are considered ambiguous. Partition of energy is considered negligible in most cases of interest; the waste heat concept is reconsidered, and the failures of scaling to TNT are regarded primarily as a failure of the ideal gas law. LA-1665 is concerned with the preparation of height of burst curves. In the reflection process over ideal surfaces, the usual subdivision into regions of regular and Mach reflection is considered inadequate, and the reflection process is subdivided into five zones: regular reflection, transition reflection, low stem height Mach reflection, high stem height Mach reflection, and hemispherical reflection. On the basis of these concepts, the reflected static pressures and dynamic pressures are deduced as a function of free air pressure and angle of incidence, from which the height of burst curve applicable to an ideal surface is deduced and drawn. A theory of surface effects is postulated in two parts for reduction in peak pressure over real surfaces. The first is categorized as mechanical effects, which include dust loading, surface viscosity and roughness, turbulence, flow effects, shielding, and ground shock. Based on these concepts, the height of burst curves that are applicable in the presence of mechanical effects are deduced. The category of thermal effect is postulated in two parts: the radiation from a bomb is sufficiently strong and violent so that the ground surface may literally blow up prior to shock arrival but at least creates a layer of dust or smoke-laden air near the surface in which subsequent radiation is absorbed, thus forming a layer of hot air near the surface. The second part of the postulate is that once such a layer is formed, the hydrodynamics of the wave entering it are violently altered by mechanisms described as strong precursor action and weak precursor action. Based on these concepts, the thermal height of burst curves are drawn for 1 kt and shown to be appropriate over a fair range of scaling. (auth)

4803 (NASA-TN-D-588) PROCEEDINGS OF CONFERENCE ON RADIATION PROBLEMS IN MANNED SPACE FLIGHT, JUNE 21, 1960, WASHINGTON, D. C. George J. Jacobs, ed. (National Aeronautics and Space Administration, Washington, D. C.). Dec. 1960. 100p. OTS.

Problems discussed include the present status of physical measurements of radiation in space, the interpretation of these measurements in terms of biological effectiveness, further studies needed to define the radiation problems in manned space flight, and how these additional studies may best be accomplished. (auth)

4804 (NP-9609(Vol.I)) RESEARCH SUMMARY NO. 36-5, VOLUME I FOR THE PERIOD AUGUST 1, 1960 TO OCTOBER 1, 1960. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Oct. 15, 1960. 69p. Contract NASw-6.

Progress is indicated on various research projects in the fields of space research analysis, systems analysis, guidance and control, deep-space instrumentation facility, communications systems, communications elements, and telemetering and space vehicle communication systems. (See also NP-9438.) (W.D.M.)

4805 (NP-9609(Vol.II)) RESEARCH SUMMARY NO. 36-5, VOLUME II FOR THE PERIOD AUGUST 1, 1960 TO OCTOBER 1, 1960. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 1, 1960. 59p. Contract NASw-6.

Research progress is indicated in the areas of physics, gas dynamics, materials, engineering, applied mathematics, wind tunnel and environmental facilities, solid propellant propulsion, and liquid propellant propulsion. (For preceding period see NP-9438.) (W.D.M.)

4806 (ORNL-3017) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1960. (Oak Ridge National Lab., Tenn.). Dec. 6, 1960. 140p. Contract W-7405-eng-26. OTS.

Separate abstracts were prepared for the following sections of this report: theory of dislocations; theory of radiation damage; low-temperature irradiation studies; dislocation interactions; investigations of metal surfaces; alloy studies; electron microscope studies; surface bombardment of solids; brittle fracture of metals; semiconductor studies; alkali halides; coolant crystals; graphite and ceramics; polymers; dosimetry studies; high-temperature fuel materials; and radiation metallurgy. (W.L.H.)

4807 (TID-3522(4th Rev.)) PEACEFUL USES OF NUCLEAR EXPLOSIONS. A Literature Search. Hugh E. Voress, comp. (Office of Technical Information Extension, AEC). Nov. 1960. 12p. OTS.

A bibliography containing 126 references is presented on the peaceful uses of atomic explosions. (C.J.G.)

4808 (TID-7599) PROCEEDINGS OF THE EIGHTH CONFERENCE ON HOT LABORATORIES AND EQUIPMENT, SAN FRANCISCO, CALIFORNIA, DECEMBER 13-15, 1960. (American Nuclear Society, Chicago). 556p. OTS.

Fifty-two papers presented at the Eighth Conference on Hot Laboratories and Equipment held at San Francisco, California, December 13 to 15, 1960, are given. The papers are grouped under the following headings: hot laboratory facilities and hot cells; general purpose manipulators and viewing; shielding and experiments; and glovebox design and specialized equipment. Fifty-one of these papers are covered by separate abstracts. One paper was previously abstracted for NSA. (M.C.G.)

4809 (TID-7599(p.1-12)) THE DESIGN AND CONSTRUCTION OF THE SITE 401 DISASSEMBLY FACILITY. William H. Moran (California. Univ., Livermore. Lawrence Radiation Lab.). (UCRL-6100).

The design and construction of the Site 401 Disassembly Facility are described. A wide variety of considerations had to be made in the design from both construction and operation viewpoints. Some of the considerations discussed are shielding, ventilation, manipulators, versatility, and operation, as well as an over-all description of the facility. (auth)

4810 (TID-7599(p.13-23)) HOT-AREA CONCEPT FOR RADIATION TEST FACILITIES. John L. Colp (Sandia Corp., Albuquerque, N. Mex.).

The hot-area concept, that of a large-shielded hot-analysis area 60 by 100 ft instead of the usual several small hot cells, is used in the design of the Sandia Engineering Reactor Facility. The shielding wall along this hot area contains six shielding windows and master-slave manipulator positions. Development of the hot-area concept required parallel development of a means of remotely moving radioactive objects about the area which led to construction of a robot mobile remote handler equipped with two mechanical arms and two television camera eyes. A robot fork truck and a robot radio-controlled tug are also used. In addition to lower costs of construction and operation, the hot area offers distinct advantages of convenience, flexibility, and safety over conventional hot-cell plans. (auth)

4811 (TID-7599(p.24-49)) NEW HOT CELLS AND HOT LABORATORIES. Y. Duvaux, M. Jacquemin, A. Junca, and E. De Robien (France. Commissariat à l'Énergie Atomique, [Paris]).

Different new hot cells are described. Some of them are devoted to the production of radioisotopes or irradiation. The others were built beside the swimming pool reactors walls in order to be in a position to directly communicate with the reactors by means of an air/water lock. Grenoble Hot Laboratory is also described with its α-β glove-box laboratories and hot-cell facility. This laboratory was designed with a large flexibility and the possibility of extension. (auth)

4812 (TID-7599(p.50-72)) OPERATIONS IN THE HIGH ACTIVITY HANDLING BUILDING, B.459, ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL. J. E. Bown and A. B. Ritchie (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The High Activity Handling Building (B.459) is a general purpose handling facility in operation since January 1958. The facility is concerned with a wide variety of work such as dismantling of in-pile loops, fuel-element examination, and precision machining of mechanical test specimens. Special machine tools for hot-cell use were designed and constructed. Further development is proceeding. The equipment, operational difficulties, and the problems of contamination control and productivity are discussed. (auth)

4813 (TID-7599(p.73-7)) AN ALPHA BETA GAMMA METALLURGY CELL AT DOUNREAY. S. A. Cottrell and J. E. Manson (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Works, Caithness, Scotland).

A small facility was built at Dounreay to handle irradiated fuels with activities up to the 100-Mev-curie level. The main feature is that the cell contains a 10-ft diameter rotating table which carries most of the equipment and delivers it to the operating position at the front of the cell or the maintenance port at the rear. A large glass window gives a view of the whole cell and master slave manipulators are used. The cell atmosphere can be chosen to suit the requirements and is filtered, recirculated, and purified. Maintenance or personnel entry is at the rear of the cell via a shower area leading to a steel door covering the access panel. The cell is at present used for metallography, density measurements, and heat treatment. (auth)

4814 (TID-7599(p.78-92)) REMOTE HANDLING OF IRRADIATED ALPHA ACTIVE MATERIALS IN THE METALLURGY DIVISION, A.E.R.E., HARWELL. J. H. Venables (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

Methods used in the handling of α, β, and γ active materials in the remote handling section of the Metallurgy Division at Harwell are described. These materials include plutonium, U^{233}, and beryllium alloys and compounds. All operations, regardless of the degree of toxicity, are carried out in free standing lead cells containing α tight boxes. For the type of work involved, this method has given greater flexibility of operation which together with excellent contamination control has improved efficiency within the section. The experience gained on the lead cells was used in the design of a suite of large concrete cells which may be used under α conditions, if required, by the incorporation of a mobile dry box. (auth)

4815 (TID-7599(p.93-100)) DESIGN AND CONSTRUCTION OF THE REPUBLIC AVIATION HOT LABORATORY. T. R. Cuerou and R. L. Zimmerman (Republic Aviation Corp., Farmingdale, N. Y.).

Republic Aviation Corporation constructed a hot laboratory, including two high-intensity Co^{60} irradiation cells, as a part of its accelerated research and development program in the aero-space field. Ilmenite concrete was selected for the cells as the high-density shielding material in consideration of its cost and availability. Special care had to be taken in the grading and pouring of ilmenite because no data on these processes were available. Equipment is provided in the laboratory for storing and using high-level sealed sources with maximum flexibility. A thorough radiation safety program is established through use of monitoring equipment and rigorous operating procedures. (auth)

4816 (TID-7599(p.101-14)) THE GENERAL ATOMIC HOT CELL FACILITY. F. L. Brown, Leonard Bailey, and Bernard Turovlin (General Atomic Div., General Dynamics Corp., San Diego, Calif.).

The General Atomic Hot Cell Facility contains two small kilocurie cells and one large megacurie cell in an arrangement which provides the equivalent of four or five small cells for capsule examinations while retaining the space required for handling full-size reactor components. Handling and operating equipment is designed to permit remote installation in the large cell so that equipment changes can be made without disturbing the progress of other operations in the same cell. Cell space and equipment are provided for decanning and machining operations, mechanical testing, and metallographic preparation and examination. (auth)

4817 (TID-7599(p.115-25)) THE BETTIS HOT LABORATORY. Arthur L. Maharam (Nuclear Materials and Equipment Corp., Apollo, Penna.) and Herman K. Lembersky (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh).

The hot laboratory located in the Bettis Atomic Power Laboratory of Westinghouse Electric Corporation is described. Originally the laboratory contained five kilocurie cells, three megacurie cells, and supporting facilities. Two megacurie cells, a metallography cell, waste disposal facilities, and decontamination facilities were added to provide equipment for postirradiation examination of materials. Preirradiation laboratories, machine shops, a change room, storage rooms, six megacurie cells, and an α-γ facility were added later. The functions of all these facilities are discussed. (M.C.G.)

4818 (TID-7599(p.126-31)) CANEL HOT LABORATORY. Robert V. Steele (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown).

A new hot laboratory is in operation at the Pratt & Whitney Aircraft Connecticut Nuclear Engine Laboratory. The building design is based on operating experience gained at Pratt & Whitney Aircraft Hot Cell Facilities, Livermore, Calif. The seven cells and associated laboratories, waste handling area, laundry, and shops in one building, which constitute a completely integrated operation, are described. (auth)

4819 (TID-7599(p.132-43)) ARGONNE CHEMISTRY HOT LABORATORY. D. C. Stewart, R. F. Buchanan, P. R. Fields, F. T. Hagemann, W. C. Mohr, E. P. Steinberg, and C. H. Youngquist (Argonne National Lab., Ill.).

A hot laboratory wing planned as an addition to the chemistry building at Argonne National Laboratory is in the final stages of detailed design. It is expected that construction will start early in 1961 and that the building will be com-

pleted in the late summer of 1962. The most notable feature of the facility will be a multicelled three-story "cave complex." The wing as a whole, to be known as Wing M to Building 200, will also include a number of support areas for the cave complex, a series of laboratories for high α work, plutonium analytical service, and for general radiochemical research. It will also house a heavy-element isotope separator for preparation of separated heavy-element nuclides. (auth)

4820 (TID-7599(p.144-56)) THE HOT CELL SYSTEM OF THE BELGIAN HIGH FLUX MATERIALS AND ENGINEERING TEST REACTOR BR2. J. P. Valentin (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire).

The unique features of the BR2 hot-cell system are vertical stacked arrangement, 60,000 curies at 2.75-Mev capacity, and a 53-ft-high main cell. This system is capable of handling, examining, and disposing of all kinds of equipment irradiated in the reactor. The cells are being built at the Centre d'Etude de l'Energie Nucléaire, Mol, Belgium, and completion is scheduled for spring 1961. The basic philosophy of design is to provide a maximum versatility to follow the extreme flexibility of the reactor itself. (auth)

4821 (TID-7599(p.157-66)) A GAMMA IRRADIATION FACILITY DESIGNED TO SIMULTANEOUSLY ACCOMMODATE A VARIETY OF EXPERIMENTS. J. D. Randall and J. A. Reuscher (Texas. Agricultural and Mechanical Coll., College Station).

A high-level γ irradiation facility under construction at the A. & M. College of Texas is described. The facility houses 2000 curies of Co^{60} and is designed to accommodate a variety of research projects which require dose rates from 1 r/hr to greater than 10^5 r/hr. Three distinct irradiation areas associated with one source provide this wide variation in dose level. (auth)

4822 (TID-7599(p.167-74)) HOT FACILITIES OF C.N.R.N., ITALY. A. Cacciari, C. Cesarano, C. Lepscky, and O. Nepi (Italy. Comitato Nazionale per le Ricerche Nucleari. Laboratorio di Metallurgia e Chimica Industriale, Milan).

An irradiation program is being carried out by the C.N.R.N. Two hot facilities were planned in order to fulfill the requirements of this program. The first one is a high-level dismantling facility, and it was obtained from an already existing γ facility. The second one is a hot laboratory for metallurgical examination of specimens up to 500°C (1 Mev). This facility includes five concrete cells, a small lead brick cell which houses the metallograph, and a low-level radiochemistry laboratory. (auth)

4823 (TID-7599(p.175-84)) RADIOISOTOPE PRODUCTION BUILDING. C. Fisher, R. Henry, and J. M. Courouble (France. Commissariat à l'Énergie Atomique, [Paris]).

A building was especially designed and erected for large-scale production of radioisotopes. It was designed to achieve complete separation between a "hot area" where handling enclosures are placed and a "cool area" where people stand to operate the equipment but where no active material is brought in. The "hot area" consists of an active corridor the walls of which are made of a thin metal partition; boxes are attached to this partition by a gasket that seals the laboratory against contamination. (auth)

4824 (TID-7599(p.185-98)) A HIGHLY ACTIVE PILOT PLANT FOR REPROCESSING EXPERIMENTAL FAST REACTOR FUELS. K. Hartley and T. W. Allen (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Works, Caithness, Scotland).

A highly active pilot plant is described. It provides for investigation of the complete reprocessing of newly developed fast reactor fuels. The three cells and their auxiliaries occupy a single-story building of approximately 3000 sq ft floor area built as a flexible research tool. The building is situated adjacent to the irradiated fuel examination block from where it may conveniently receive the irradiated fuels. (auth)

4825 (TID-7599(p.199-209)) PLANT FOR SEPARATION OF POLONIUM-210 FROM BISMUTH. R. Henry and J. Desroches (France. Commissariat à l'Énergie Atomique, [Paris]).

A pilot plant for the separation of polonium from bismuth was built in a 10×15 m laboratory. It is divided in two different parts: one α-γ box for decanning and a group of chemical operation boxes (α and α-γ) for the polonium chemical separation. A system of double enclosures was chosen for the chemical boxes. A new conveyor system was built, and each box is equipped with a triple ventilation system. (auth)

4826 (TID-7599(p.210-23)) A VERSATILE UNIVERSITY LABORATORY FOR STUDIES ON THE BASIC CHEMISTRY OF ALPHA EMITTERS. Fritz Weigel (Munich. Universität. Institut für Anorganische Chemie).

The facility described is equipped with special enclosures for the following type of work: aqueous and dry chemistry, x-ray diffraction, emission spectroscopy, and micrometallurgy of weighable amounts of α-emitting elements and their compounds. The enclosures, which are described in detail, are of the type which was first introduced into this kind of work at the Berkeley Lawrence Radiation Laboratory. The particular advantages for this type of laboratory for teaching and research of graduate students are discussed. It is shown that the otherwise hazardous work with strong α-emitters becomes relatively simple in the gloved box, and it becomes possible to work with several different radionuclides at the same time, something which is impossible on the open bench because of the danger of cross contamination. (auth)

4827 (TID-7599(p.224-9)) A COMPACT MOBILE MANIPULATOR. J. A. Brown (Esso Research and Engineering Co., Linden, N. J.) and W. A. Koelsch, Jr. (Koelsch Electronic Development Co., Boise, Idaho).

A compact mobile slave unit consisting of an articulated arm and hand mounted on a self-propelled dolly is described. Both the arm and the dolly are powered by d-c motors supplied from a simple transistor power unit through a trailing cable. Control is effected by varying the voltage and polarity from a remotely located control box. The manipulator can carry out generalized manual operations in uninhabitable areas. It can enter and leave under remote control, and so can serve a number of alternate areas without special installation. (auth)

4828 (TID-7599(p.230-8)) HINGED ARM POLAR MANIPULATOR POSITIONER MOUNTED ON A RADIO CONTROLLED MOBILE BASE. W. C. Mohr and C. H. Youngquist (Argonne National Lab., Ill.).

A manipulative system that is an attempt to bridge the gap between presently available systems and the more sophisticated robot manipulators of the future is described. The manipulator positioner provides a volume of manipulative coverage comparable to a bridge mounted telescoping tube assembly. The mobile base is battery powered, radio controlled, and guided by rails set in the floor. These features allow the mobile base to carry the manipulator and positioner between cells unencumbered by power or control cables. (auth)

4829 (TID-7599(p.239-51)) A RADIATION STABLE HEAVY DUTY ELECTROMECHANICAL MANIPULATOR. J. E. A. Graae, D. C. Hampson, I. Pollack, M. Levenson, J. H. Schraidt, and G. J. Bernstein (Argonne National Lab., Ill.).

The development of pyrometallurgical processes for purifying spent reactor fuels emphasized the need for a high-capacity (750-lb lift) radiation-stable manipulator. No existing manipulator appeared capable of functioning in a sealed area for more than a few hundred hours under the sustained radiation levels of 10^4 to 10^6 r/hr, which are anticipated. Therefore it was necessary to design a manipulator which could operate for a long period in the sealed high-radiation-level process cells. A prototype manipulator operated successfully under an extensive testing program in a full scale mock-up facility. (auth)

4830 (TID-7599(p.252-62)) AN ELECTROHYDRAULIC BILATERAL SERVOMANIPULATOR. R. S. Mosher (General Electric Co. General Engineering Lab., Schenectady, N. Y.).

A heavy-duty bilateral manipulator was constructed for an industrial nuclear engineering laboratory. Several noteworthy design features provide unusual strength and dexterity. However, problems of cost and complexity indicate that considerable effort is needed to adapt this device to a broader range of applications. (auth)

4831 (TID-7599(p.263-76)) SETF REMOTE VIEWING TECHNIQUES. J. H. Burton (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Windowless hot cells in the SNAP Experimental Test Facility necessitated the development of unique remote viewing equipment and techniques. The development was undertaken at Atomics International under contract to the Office of Aircraft Reactors of the Atomic Energy Commission as part of the SNAP 2 program. A description is given of the facility features and equipment that affect the remote viewing program, and the equipment and techniques developed. Mentioned are the Traverse Television System, through-roof television camera, through-roof periscope, miniature television camera, and procedures for handling and setting up the remote viewing equipment. (auth)

4832 (TID-7599(p.297-305)) OPERATION OF A PLUTONIUM HOT CELL. P. J. Peterson and J. L. Green (Los Alamos Scientific Lab., N. Mex.).

Operation of a facility for research and development work with reactor-irradiated plutonium on a kilogram scale combines the difficulties of a plutonium glove-box operation and those of remote manipulation in a shielded cave. The installation described provides a hermetically sealed glove box, within which all experimental work is conducted, situated inside a shielded cell. Manipulation within the box is done by means of Argonne model No. 8 manipulators working through plastic booting. These cells have been in use since July 1959. The operational procedures developed during their first year are described along with the apparent advantages and difficulties of this particular design. (auth)

4833 (TID-7599(p.306-15)) INSPECTION OF IRRADIATED MATERIALS AT DOUNREAY. E. Edmonds and K. M. Swanson (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Works, Caithness, Scotland).

The high-activity examination facility at Dounreay is described. It is designed to handle up to 105-Mev curies and has been in operation since December 1959. Modifications to restrict contamination spread and facilitate decontamination and entrance to the cells for maintenance are discussed. Changes in the equipment within the cells to meet new commitments and increase flexibility are outlined. The operation of the physical and mechanical testing apparatus is discussed. (auth)

4834 (TID-7599(p.316-23)) OPERATIONAL EXPERIENCE IN THE COMPONENTS DEVELOPMENT HOT CELLS AT ATOMICS INTERNATIONAL. J. M. Davis and E. D. Grazzini (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The Components Development Hot Cells at Atomics International, in operation since April 1959, are described. The workload is sufficiently heavy and varied to provide quite decisive testing of the facility design, equipment, and operational procedures. Some facility design features such as the mock-up shop, decontamination cells, and manipulator repair shop proved most satisfactory. The cell ventilation system needs considerable improvement. In-cell equipment is relatively satisfactory. Operational procedures in waste handling, contamination control, personnel exposure, and cell set-up changed as experience was gained. However, they still require improvement. (auth)

4835 (TID-7599(p.324-31)) CHANGES IN THE DESIGN AND OPERATIONAL MANAGEMENT OF BATTELLE'S HOT-CELL FACILITY. J. H. Saling, E. C. Lusk, R. N. Eddy, and J. E. Gates (Battelle Memorial Inst., Columbus, Ohio).

Several additions to the Battelle Hot-cell Facility and some changes in the operational management that occurred during five years of operation are described. The additions to the facility include a contaminated equipment storage area, a new loading dock, a solid and liquid waste disposal area, an addition to the machine shop, and revision of the hot locker room. The facility is now operated as a service type facility with a professional staff member as operations manager and three senior technicians as shift supervisors. A design committee of four professional staff members experienced in remote operations provides assistance in equipment design. (auth)

4836 (TID-7599(p.332-6)) THE USE OF SOLVENT-SOLUBLE FILMS IN DECONTAMINATION. J. W. Schulte, F. T. Fitzgibbon, and D. S. Shaffer (Los Alamos Scientific Lab., N. Mex.).

Experimental results using soluble films as a simple and effective means of remotely decontaminating hot cell and drybox equipment are presented. Experience over a three year period proved that equipment, coated with a film of Apiezon W or Flo-Master ink prior to contaminating, can be decontaminated from >20 r/hr to ~20 mr/hr by stripping the film with a suitable organic solvent. Preliminary results with H_2O-soluble films indicate that films and contamination can be removed with H_2O, high-pressure air–H_2O mixtures, or steam. Possible applications for these techniques in the control of contamination are discussed. (auth)

4837 (TID-7599(p.337-57)) MECHANICAL DEJACKETING OF SRE FUEL. C. D. Watson, G. A. West, W. F. Schaffer, B. B. Klima, and J. B. Adams (Oak Ridge National Lab., Tenn.).

Equipment to mechanically disassemble, dejacket, and recan spent SRE fuel was designed, fabricated, and installed in a shielded segmenting facility at Oak Ridge National Laboratory. Remote performance testing of the equipment with unirradiated fuels showed that all operations are feasible. It is expected that irradiated fuel will be processed at a rate of 250 to 500 kg of uranium per day. Mechanical processing of spent fuel should begin early in 1961. (auth)

4838 (TID-7599(p.358-63)) DECONTAMINATION EVALUATION FACILITY. G. E. Neibaur (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A facility for studying decontamination problems is described. Called the Irradiated Rupture Prototype, it is designed to circulate water at 600°F and 2000 psi under gross fission product contamination conditions. It is prototypical of a high-temperature pressurized-water reactor system. Contamination is accomplished by purposely rupturing an irradiated fuel element in a detachable cask designed for high temperature and pressure. Candidate decontamination processes are then evaluated in cleaning up the loop. Data on decontamination factors, corrosion, effects of filtering, dead legs, and velocity are obtained. (auth)

4839 (TID-7599(p.364-81)) CHEMICAL PROCESSING OF A PLUTONIUM FUEL ELEMENT OF THE MTR-TYPE AND SEPARATION OF THE TRANSPLUTONIUM ELEMENT FRACTION. P. R. Fields, R. K. Sjoblom, R. F. Barnes, C. H. Youngquist, and W. C. Mohr (Argonne National Lab., Ill.).

An MTR type plutonium shim rod was irradiated for two years in the MTR and processed at Argonne National Laboratory. The shim rod contained 100 curies of α activity and about 10^9 neutrons/min from the transplutonium elements, and the equivalent of 4000 curies of fission products. The processing was done in a kilocurie cell with the apparatus enclosed in collapsible plastic boxes to minimize the spread of radioactivity. The fuel assembly was dissolved in a closed system to contain the radioactive fission gases. The plutonium and transplutonium elements were isolated from the fission products and the large amounts of structural material by precipitation and ion exchange techniques. Details of the process and equipment are discussed. (auth)

4840 (TID-7599(p.382-90)) GAMMA ACTIVITY SCANNING AS A TOOL TO OBTAIN BURNUP CONTOURS OF FUEL ELEMENT ASSEMBLIES. R. J. Burian, J. E. Gates, and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio).

A technique was developed in which the relative γ activity of a fuel element is combined with results of burn-up analyses to obtain contour representation of the fuel burn-up in the element. Although the accuracy of the relative activity measurements is controlled by factors such as the production, decay, and radiation characteristics of the fission products, the use of relative γ activity scanning to obtain a burn-up contour is nonetheless a valuable tool to aid in evaluating fuel elements. It has the advantages that it can be rapidly and easily performed and it is relatively inexpensive in view of the quantity of data obtained. (auth)

4841 (TID-7599(p.391-8)) EQUIPMENT AND TECHNIQUES FOR GAMMA-SCANNING IRRADIATED REACTOR FUEL MATERIALS. D. B. West, J. B. Newton, and E. D. Grazzini (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Comprehensive systems of scintillation spectrometers, detectors, collimating orifices, and specimen transport mechanisms are in use at Atomics International's Components Development Hot Cell. These systems accomplish the γ-scanning of complete reactor fuel components, small specimens of test fuel materials, and neutron-flux monitoring wires. Applications include mapping profiles of relative burn-up, determination of the proper locations for removal of chemical burn-up analysis specimens, and assistance in the determination of reactor neutron-flux patterns. (auth)

4842 (TID-7599(p.399-402)) AN IMPROVED FACSIMILE TECHNIQUE FOR REMOTE METALLOGRAPHY. K. R. Janowski (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

A method of replicating irradiated metallographic samples was developed at Atomics International. The technique involves replicating with a Lucite block, thus overcoming problems inherent in other replicating methods. The replication technique requires no heat or pressure while yielding massive replicas suitable for both optical and electron microscopy. (auth)

4843 (TID-7599(p.403-10)) REMOTELY CONTROLLED HOT STORAGE CELL FOR HIGH-LEVEL RADIOACTIVE SAMPLES. G. Boehme (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany).

A hot storage cell was developed which may serve to store more than 1800 radioactive samples in compartment tubes under a steel plate. The tubes can be pulled out by means of a remotely controlled precision rectilinear hoist crane and driven in front of a lead glass window. Here they are charged or discharged by a master slave manipulator specially designed for this job. An exchangeable periscope serves for viewing purposes inside the cell and in the storage area beneath the steel plate, which can not be accomplished through the lead glass window. (auth)

4844 (TID-7599(p.411-20)) ATTENUATION OF COBALT-60 GAMMA RADIATION THROUGH AIR DUCTS IN CONCRETE SHIELDS. F. X. Rizzo and A. Quadrado (Brookhaven National Lab., Upton, N. Y.) and C. Eisenhauer (National Bureau of Standards, Washington, D. C.).

The manner in which γ radiation is scattered through air ducts in concrete shields was investigated. Rectangular two- and three-segment ducts with 90° turns and a range of parameters from 6 to 72 in. were employed. The behavior of the dose rate in two-segment ducts was found to vary from $1/D^2$ for large ducts to $1/D^3$ for small ducts. This suggests a dependence upon a complex solid angle relationship. Empirical equations involving the duct parameters were formulated. These equations make it possible to approximate the dose rate behavior over the range of duct sizes investigated. (auth)

4845 (TID-7599(p.421-8)) GAMMA-RAY ATTENUATION OF SHIELDING WINDOWS. Vaughn Culler (Corning Glass Works, Plainsboro, N. J.).

Nonbrowning glasses of densities 3.3 and 6.2 g/cm^3 are often used in the construction of shielding windows. The γ-ray attenuation properties of these glasses are presented in the form of nomograms which permit rapid, yet accurate, shielding calculations. Build-up factors were included in the nomograms. The nomograms permit simple determination of dose rate attenuation factors both for varying thicknesses of these glasses and for a wide range of γ-ray energies. For convenience in calculation a graph of the conversion factor from curies of a γ-ray source to dose rates at 1 ft from the source is also included. (auth)

4846 (TID-7599(p.429-40)) REMOTE ASSEMBLY OF REPROCESSED FUEL SUBASSEMBLIES FOR EBR-II. R. H. Olp (Argonne National Lab., Ill.).

Remotely operated assembly equipment and procedures used in constructing reactor core subassemblies for the first core loading of the Experimental Breeder Reactor No. 2 are described. All this equipment was designed for totally remote operation, maintenance, and replacement in a radiation field of up to 10^6 r/hr, resulting from the reprocessing of spent reactor subassemblies. The operation of this remote equipment is controlled through an electrical programming console exterior to the cell and Argonne type master slave manipulators. (auth)

4847 (TID-7599(p.441-9)) A FISSION GAS COLLECTION SYSTEM. R. E. Womack (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.).

A fission gas collection system is described. It is a vacuum system which contains equipment for puncturing reactor fuel elements of almost any physical configuration, and for heating fuel specimens in any controlled atmosphere for high-temperature gas evolution studies. A minimum number of working parts are inside the shielding wall. The error of reproducibility of the system is approximately 5%. (auth)

4848 (TID-7599(p.450-7)) EVALUATION OF URANIUM SHIELDING IN THE TRANSPORTATION OF RADIOISOTOPES. J. Stuart Lichliter (California. Univ., Berkeley. Lawrence Radiation Lab.).

Uranium has several advantages as a general shielding material for radioisotope shipping containers. It has a density of 18.7, while that of lead is only 11.34. Uranium is more readily machinable than tungsten, and less expensive for large containers than the tungsten–nickel–copper alloys. Each inch of uranium gives about 65% more shielding than 1 inch of lead for 1-Mev gamma rays. The uranium metal is easily contained to prevent contamination. In weekly air shipments of Na^{24} from Oak Ridge to Lawrence Radiation Laboratory, uranium shielding material saved an estimated $5000 per year in shipping costs. Various combinations of nesting uranium containers were designed and fabricated for safe shipment of irradiated slugs from reactors. Special problems of design to meet complex requirements of air transportation are considered. (auth)

4849 (TID-7599(p.458-63)) EQUIPMENT FOR THE COLLECTION AND PRESSURE MEASUREMENT OF FISSION GASES FROM EGCR CAPSULES. M. T. Morgan, M. F. Osborne, H. E. Robertson, and J. G. Morgan (Oak Ridge National Lab., Tenn.).

Hot-cell equipment for the determination of fission gas evolution from UO_2 fuel in stainless-steel capsules was developed at ORNL. The equipment includes a piercing valve and a proportional sampling system designed for remote sampling of high-level gas activity. A sampling rack allows remote removal of glass bulbs which were filled with fission gas. Additional equipment measures the gas pressure at high temperatures to include pressure contributions from fission product cesium and iodine compound vapors. Pressure transmitters and seals were developed to operate at 1650°F without cooling. (auth)

4850 (TID-7599(p.464-74)) MODIFICATION AND REPAIR OF THE HRE-2 CORE VESSEL. E. C. Hise (Oak Ridge National Lab., Tenn.).

In April 1958 and in January 1960 holes melted through the Zircaloy core vessel of the Homogeneous Reactor Experiment No. 2. Investigations were made to determine the cause of and possible cure for the failures. Tools were designed and developed to repair the damage and effect the cure. Under working conditions of extreme physical limitations and radiation hazard the core vessel was inspected, measured, and cleaned. The diffuser plates were removed with the aid of a miniature underwater heliarc cutting torch, a sample of the core wall was obtained for metallographic examination, and the holes were patched. (auth)

4851 (TID-7599(p.475-84)) ALPHA-GAMMA CONTAINMENT BOX. C. H. Youngquist, J. F. Lindberg, W. C. Mohr, and R. B. Wehrle (Argonne National Lab., Ill.).

The chemical processing of α-γ neutron activity in a new chemistry cave at Argonne will be in large flexible transparent containment boxes. These boxes are sealed, and their construction and handling will permit the introduction of master slave manipulators into boots which are part of the box. Manipulators will have full freedom of motion and will be able to discard jaws and be removed from box while a complete seal is maintained. Utilities and ventilation duct connections are made using manipulators. Transfer locks for the in and out passage of material will be provided. When work is completed, the containment box can be collapsed and discarded as active waste. These boxes were development tested only and were not used under actual working conditions. (auth)

4852 (TID-7599(p.485-93)) LOW COST GLOVEBOXES. R. F. Malecha, H. O. Smith, J. H. Schraidt, J. V. Natale, N. E. Ross, and H. O. Brown, Jr. (Argonne National Lab., Ill.).

A glove box, simple in construction, universal in plutonium handling capabilities, and economical to build was desired. A thorough study was made of the means and methods involved in producing a suitable low cost glove box with a clean interior. Tests proved the feasibility of using safety glass fastened and sealed to a metal frame with an automobile type weatherstrip. Modular structural elements allow glove boxes of many lengths to be built from a few basic carbon steel components. The experience with the glove boxes now installed and in operation verifies the original conviction that a versatile glove box could be produced at a low cost. (auth)

4853 (TID-7599(p.494-505)) ATMOSPHERE HANDLING AND CONTROL FOR A GLOVEBOX FACILITY. L. F. Coleman, J. H. Schraidt, R. L. Breyne, and J. V. Natale (Argonne National Lab., Ill.).

A glove box facility was built which provides a high integrity barrier to the spread of contamination. All ventilation components and instruments are noncomplex commercially available items. Each glove box may be operated on either a once-through or a recirculating ventilation system. This combines the advantages of the complete independence of the once-through system when necessary with the low gas consumption rate possible with the recirculating system when its use is permissible. The system permits the choice of room air, dry air, nitrogen, or argon as the atmosphere in any glove box, and guarantees a negative pressure in each glove box. (auth)

4854 (TID-7599(p.506-10)) PRESSURE REGULATION IN ACTIVITY ENCLOSURE. J. Stafford Peck (California. Univ., Berkeley. Lawrence Radiation Lab.). (UCRL-9147)

Enclosure systems for maximum security of activity containment have minimum practical leakage and very low ventilation rates, and require some method to compensate for internal pressure changes resulting from leaks, vapor production, and physical volume changes. The merits of combining modes of pressure regulation and volume compensation are considered in a system to handle surges and long-term changes. The design, function, and successful use of a surge regulator at Lawrence Radiation Laboratory, Berkeley, is described. (auth)

4855 (TID-7599(p.511-17)) A REMOTE LOW TEMPERATURE TENSILE TEST FACILITY. S. B. McRickard and J. G. Y. Chow (Brookhaven National Lab., Upton, N. Y.). (BNL-4752)

A facility for performing tensile tests on irradiated metals at temperatures from room temperature down to liquid helium temperatures is described. A tensile tester is operated remotely within a hot cell and is supplied with liquid gas refrigerants from without. The tensile frame was

modified to conduct the test inside a double walled Dewar suspended beneath the movable cross head. An optical comparator is used to measure the plastic strain the special contoured specimen has undergone. From the data thus obtained a true stress-true strain curve, yield stress, fracture stress, reduction in area and, with several samples, the ductile-to-brittle transition in tension could be found. (auth)

4856 (TID-7599(p.518-22)) A SIMPLE RAPID WELDER FOR PLASTIC BAGS AND SLEEVES. Herbert P. Cantelow, Leonard E. Miles, and Billy D. Abram (California. Univ., Berkeley. Lawrence Radiation Lab.).

An effective yet simple welder for plastic film was developed at Lawrence Radiation Laboratory. Because the heating element used is comprised of a single length of nichrome ribbon, no warm-up is required and the weld cools very quickly; a typical complete operation requires less than a minute. A convenient spade type handle is provided so that the welder can be operated with one hand. It is readily portable, inexpensive, and quick and easy in operation, all features which encourage the use of positively sealed bags when removing contaminated objects from glove boxes and other enclosures. (auth)

4857 (TID-7599(p.523-32)) DESCRIPTION OF THE HIGH ACTIVITY GAMMA SPECTROSCOPIC ANALYSIS SYSTEM IN USE AT HANFORD, REDOX LABORATORY. W. H. Zimmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The equipment used in a system for the analysis of γ spectrum over a large range of activity levels is described. Two γ detectors were used to cover a range of 0 to 100 r. The high-level detector was in a horizontal plane, with the sample in a separate mobile shield. High-activity solid samples were remotely prepared for analysis in vinylite envelopes sealed by an induction current. (auth)

4858 (TID-7599(p.533-42)) FACILITIES AT HANFORD FOR THE MANUFACTURE OF PLUTONIUM CERAMIC FUELS. John B. Burnham, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A general description of the layout and design philosophy of Hanford's Plutonium Fuels Pilot Plant (PFPP) is presented. The design and equipment of the ceramic fuels portion of the PFPP are described in detail. The capabilities for ceramic fuel fabrication include sintering, swaging, and vibratory compaction techniques. (auth)

4859 (TID-7599(p.543-7)) SIMPLIFIED FILTER CHANGE WITHOUT AN INTERRUPTED OR UNFILTERED EXHAUST. R. A. Blomgren (Argonne National Lab., Ill.).

A simplified push-through system was developed for changing air cleaning filters when γ shielding is not required. Personnel are safeguarded from the hazardous particulate material during the filter changing operation because the contaminated filter is contained at all times at a pressure below atmospheric. Complete filtration is maintained without interruption during the filter change operation. The filter is sealed both in the filter housing and in the disposal container by urethane foam gaskets mounted to the unmodified frame of the filter. (auth)

4860 MATERIALS IN NUCLEAR APPLICATIONS: SYMPOSIUM ON RADIATION EFFECTS AND DOSIMETRY; SYMPOSIUM ON POSTIRRADIATION EFFECTS IN POLYMERS; PAPERS ON INDUSTRIAL WATER FOR REACTOR USE; SYMPOSIUM ON CERAMICS IN NUCLEAR ENERGY. Presented at the Third Pacific Area National Meeting, American Society for Testing Materials, San Francisco, Calif., October 12, 14, 15, and 16, 1959. ASTM Special Technical Publication No. 276. (American Society for Testing Materials, Philadelphia). 1960. 350p. $8.25.

A total of 27 papers are included which were presented as three symposia (Radiation Effects and Dosimetry, Postirradiation Effects in Polymers, and Ceramics in Nuclear Energy) at the Third Pacific Area National Meeting of the ASTM in San Francisco on Oct. 12 to 16, 1959. Two papers on industrial water for reactor use are included. The topics of the papers range from dosimetry nomenclature and standards and radiation effects on steel to fuel element fabrication. Discussions are given. Twenty-four papers are abstracted; three have been previously abstracted. (D.L.C.)

4861 ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 10. Emilio Segrè, ed. Palo Alto, Calif., Annual Reviews, Inc., 1960. 624p.

Reviews are included on such topics as: neutrino interactions; nuclear interactions of heavy ions; cosmic-ray showers; bubble chambers; optics of high-energy beams; nuclear structure effects in internal conversion; recoil techniques in nuclear reaction and fission studies; labeling organic compounds by recoil methods; nucleon-nucleon scattering experiments; shell model interpretation of energy levels of light nuclei; nuclear methods for subsurface prospecting; cosmic ray experiments during IGY; cellular radiobiology; and vertebrate radiobiology. Cumulative indices are included of chapter titles and contributing authors for all previous volumes. (B.O.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

4862 (A/AC.82/G/L.476) THE CONCENTRATION OF CESIUM, RUBIDIUM AND POTASSIUM IN HUMAN BODY WITH REFERENCE TO CESIUM-137. Noboru Yamagata (Japan. National Inst. of Public Health. Radiation Health Lab.). Aug. 1960. 19p.

Data are tabulated from measurements made at the Institute of Public Health, Tokyo, on the concentration of cesium, rubidium, and potassium in human tissues and organs. The determination of Cs^{137} was made on the same materials and the results are presented in the separate report entitled "The Concentration of Cesium-137 in Human Tissues and Organs by N. and T. Yamagata." Analytical errors for the rubidium determination are ±3 per cent which was made by a flame photometric technique. Cesium-133 was determined by a neutron-activation method and the errors are ±10 per cent and the errors on the Cs^{137} to Cs^{133} isotopic ratio are ±20 per cent. Routine analyses of the various materials of which the concentration of Cs^{137} has previously been reported are going on and the final discussion of the interrelationships between the environments and the human body with respect to the isotopic ratio of cesium will be made after the analyses have been completed. (auth)

4863 (COO-221) INTERIM REPORT OF STUDIES OF Sr^{90} IN ADULT BEAGLES. B. J. Stover, J. H. Dougherty, C. W. Mays, and C. E. Rehfeld, comps. (Utah. Univ., Salt Lake City. Coll. of Medicine). Aug. 25, 1960. 14p. (A/AC.82/G/L.480).

Progress is reported in studies of the effects of Sr^{90} in adult beagles. This study constitutes a part of the comparative study of the long-term biological effects of Ra^{226}, Pu^{239}, Ra^{228} (MsTh), Th^{228} (RdTh), and Sr^{90}. The principal site of deposition of each of these five radionuclides, when

administered intravenously, is the skeleton. Thus a major part of the program is directed toward assessing long term skeletal effects of the radiation from these radionuclides. In addition, extensive hematological studies are in progress, as are other pertinent clinical studies. Detailed studies of the metabolism of the radioactive isotopes are also being made to provide the requisite dosimetric information since a part of the over-all goal of the laboratory is to determine what relation, if any, exists between the onset and/or development of biological effects and various functions of dose rates and time. A total of 72 dogs, comprising 6 dose levels of Sr^{90}, have been under study for periods of time ranging from 8 months to 5.6 years. To date we have observed only one bone tumor in these dogs, and no leukemias have been observed. (auth)

4864 (LAMS-2455) BIOLOGICAL AND MEDICAL RESEARCH GROUP (H-4) OF THE HEALTH DIVISION—SEMIANNUAL REPORT [FOR] JANUARY THROUGH JUNE 1960. (Los Alamos Scientific Lab., N. Mex.). July 1960. 244p. Contract W-7405-eng-36. OTS.

Separate abstracts were prepared on 36 sections of this report. (C.H.)

4865 (LAMS-2455(p.9-13)) RETENTION AND EXCRETION OF CESIUM^{137} BY MICE DURING CHRONIC ORAL ADMINISTRATION. I. PREDICTION OF EQUILIBRIUM LEVEL FROM ACUTE EXPOSURE PARAMETERS. J. E. Furchner, C. R. Richmond, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

Data are presented from a study on the retention of Cs^{137} following acute oral intubation in mice. A comparison was made of observed and predicted retention levels. (C.H.)

4866 (LAMS-2455(p.14-17)) EXCRETION OF CESIUM^{137} AS A FUNCTION OF AGE IN MICE. J. E. Furchner, C. R. Richmond, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

Data are tabulated on the effect of age on the excretion of Cs^{137} by mice. (C.H.)

4867 (LAMS-2455(p.18-23)) EFFECT OF A CARBONIC ANHYDRASE INHIBITOR (DIAMOX) ON CESIUM^{137} EXCRETION IN RATS. C. R. Richmond, J. E. Furchner, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

2-Acetylamino-1,3,4-thiadiazole-5-sulfonamid (Diamox) accelerated the excretion of intraperitoneally administered Cs^{137} in rats. (C.H.)

4868 (LAMS-2455(p.24-31)) RETENTION OF BARIUM^{133} IN MICE, RATS, AND DOGS. C. R. Richmond, J. E. Furchner, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

The retention of Ba^{133} was measured by whole-body counting techniques in mice, rats, and dogs. Data are tabulated. (C.H.)

4869 (LAMS-2455(p.32-7)) METABOLISM OF RUTHENIUM^{106} CHLORIDE IN MAMMALS STUDIED WITH THE AID OF WHOLE-BODY GAMMA RAY ASSAY TECHNIQUES. I. MICE AND RATS. C. R. Richmond, J. E. Furchner, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

The metabolism of Ru^{106} chloride was studied in mice and rats with the aid of whole-body gamma counting techniques. Data are tabulated. Results indicate that bone, rather than kidney, should be considered as the critical organ following oral or parenteral administration. (C.H.)

4870 (LAMS-2455(p.38-40)) RETENTION OF IRIDIUM^{192} IN MICE AND RATS FOLLOWING ORAL ADMINISTRATION. J. E. Furchner, C. R. Richmond, and G. A. Trafton (Los Alamos Scientific Lab., N. Mex.).

Results are reported from a study of the retention as a function of time of Ir^{192} in mice and rats after oral administration. Whole-body counting techniques were used to determine residual activities. (C.H.)

4871 (LAMS-2455(p.41-5)) POTASSIUM CONTENT OF DOGS, CALCULATED FROM NATURAL POTASSIUM^{40} LEVELS. C. R. Richmond and J. E. Furchner (Los Alamos Scientific Lab., N. Mex.).

The naturally occurring K^{40} content of 31 beagle hounds was measured in the whole-body gamma counter. Results were used in calculations of body potassium concentration of the dogs. The average potassium concentration (61.61 mEq/kg gross body weight) was found to be somewhat higher than the value of 49 mEq/kg usually given for human beings. This difference was assumed to be related to the fat-to-muscle ratio for each species. Data are tabulated. (C.H.)

4872 (LAMS-2455(p.46-9)) POTASSIUM CONCENTRATION AS A FUNCTION OF AGE IN RATS. C. R. Richmond, J. E. Furchner, and M. A. Van Dilla (Los Alamos Scientific Lab., N. Mex.).

Results are reported from tracer studies of the potassium concentration in rats as a function of age. The K^{40} concentration in rats appears to decrease rapidly between 2 and 4 months and then slowly between 4 and 24 months. (C.H.)

4873 (LAMS-2455(p.50-60)) RADIOCHEMICAL NEUTRON DOSIMETRY BY INDUCED P^{32} ACTIVITY IN SULFUR-RICH BIOLOGICAL MATERIALS. D. F. Petersen, V. E. Mitchell, and W. H. Langham (Los Alamos Scientific Lab., N. Mex.).

Incident neutron doses, based on determination of the P^{32} arising from the $S^{32}(n,p)P^{32}$ reaction in hair sulfur, were demonstrated to be in good agreement with a variety of other methods of neutron dosimetry. Improved analytical techniques increased the sensitivity of the method approximately ten-fold. The use of smaller samples made it possible to assess dose distribution and deduce orientation by performing separate analyses on hair samples obtained from various parts of the body. (C.H.)

4874 (LAMS-2455(p.61-70)) DETERMINATION OF STRONTIUM^{90} IN BONE. H. Foreman and M. B. Roberts (Los Alamos Scientific Lab., N. Mex.).

A procedure is described for the determination of micro amounts of Sr^{90} in bone. (C.H.)

4875 (LAMS-2455(p.71-3)) EFFECT OF DIETHYLTRIAMINE PENTAACETIC ACID (DTPA) ON ELIMINATION OF AMERICIUM^{241} ADMINISTERED INTRATRACHEALLY TO RATS. H. Foreman and M. B. Roberts (Los Alamos Scientific Lab., N. Mex.).

Diethyltriamine pentaacetic acid hastened the excretion of Am^{241} deposited in the respiratory tract of rats. (C.H.)

4876 (LAMS-2455(p.74-80)) NEPHROTOXICITY OF CHELATING AGENTS—A CONTINUING STUDY. H. Foreman, C. C. Lushbaugh, M. B. Roberts, and G. L. Humason (Los Alamos Scientific Lab., N. Mex.).

Progress is reported in studies of kidney lesions produced in rats following the administration of diethyltriamine pentaacetic acid or ethylenediamine tetraacetic acid. (C.H.)

4877 (LAMS-2455(p.91-4)) SEARCH FOR ZINC^{65} IN GENERAL POPULATION. M. A. Van Dilla and M. W. Rowe (Los Alamos Scientific Lab., N. Mex.).

Thirty-two young men were examined in two whole-body counters for the presence of Zn^{65}. The men were fairly homogeneous with respect to age, weight, and general physical condition. An upper limit of about 2 mμc was established for possible Zn^{65} present in these 32 subjects. (C.H.)

4878 (LAMS-2455(p.113-17)) ABSORPTION OF RADIOISOTOPES THROUGH THE SKIN: FEASIBILITY STUDY. M. A. Van Dilla and M. W. Rowe (Los Alamos Scientific Lab., N. Mex.).

A method is described for the detection of very small amounts of radioactivity absorbed through the skin. Preliminary results indicate the method is feasible for use on human subjects. (C.H.)

4879 (LAMS-2455(p.152-7)) DEPENDENCE OF RECOVERY HALF-TIME ON MAGNITUDE OF CONDITIONING DOSE OF COBALT^{60} GAMMA RAYS. J. F. Spalding and T. T. Trujillo (Los Alamos Scientific Lab., N. Mex.).

Progress is reported in a series of studies on recovery or repair rates in irradiated mice. An attempt is being made to establish the actual relationship between recovery rate and radiation dose. (C.H.)

4880 (LAMS-2455(p.223-9)) THE USE OF THE ARM COUNTER TO DETERMINE THE DEGREE OF HEPATIC FUNCTION. C. C. Lushbaugh, D. B. Hale, and R. McGill (Los Alamos Scientific Lab., N. Mex.).

Difficulties in the radioactive rose bengal test of liver function were overcome by the use of an arm counter which afforded a constant record of circulating blood-dye concentration. Blood clearance of the dye by the liver was measured directly without the complicating problems caused by hepatic blood background, biliary excretion rate, gall bladder accumulation, and the unknown location in depth of the liver within the body. Since the original blood concentration of the dye is determinable, the percentage of the dye retained in the blood after 20, 45, or any selected number of minutes can be reported, as is commonly done clinically with the bromsulphalein dye test. Preliminary results are reported from measurements on 10 normal subjects and 18 persons suffering from inflammatory hepatic disease. (C.H.)

4881 (LAMS-2455(p.230-7)) WHOLE BODY RETENTION OF IODINE^{131} FROM VARIOUS LABELED ORGANIC COMPOUNDS IN STARVING AND IRRADIATED RATS. C. C. Lushbaugh and D. B. Hale (Los Alamos Scientific Lab., N. Mex.).

The effects of starvation on the whole-body retention of I^{131} from injected labeled rose bengal, sodium diprotrizoate (miokan) or human serum albumin were studied in rats. Results indicate that food deprivation reduces the rate of excretion of radioactive iodine bound to these two dyes and the foreign protein. (C.H.)

4882 (NYO-9346) LUNG HAZARDS FROM INHALED RADIOACTIVE PARTICULATE MATTER. Final Report. (Report No. 4). Herman Cember (Pittsburgh, Univ. Graduate School of Public Health). [Sept. 14, 1960]. 49p. Contract AT(30-1)-912. OTS.

A summary of results is presented from a research project to determine where there is a difference in site, nature, and hazard associated with the inhalation and lung deposition of relatively insoluble radioactive particulate matter as compared with rapidly soluble solids or vapors or gases in molecular dispersion. It was concluded that radioactive dusts are carcinogenic and can cause cancer of the lung. The intense absorbed dose in the immediate vicinity of a single radioactive particle does not seem to present a unique hazard. Soluble particles cannot be dismissed as a lung hazard unless known to be absorbed and translocated. Atmospheric tolerance concentrations for S^{35} and Ce^{144}-Pr^{144} offer little margin of safety. Intratracheal injection was found to be an excellent technique for toxicity studies, but not for lung clearance or radioactive hazard study. (T.R.H.)

4883 (ORO-339) COMPLETE SCIENTIFIC REPORT ON BODY RETENTION OF CARBON-14. L. L. Bennett, Jr. (Southern Research Inst., Birmingham, Ala.). Nov. 4, 1960. 33p. Contract AT(40-1)-1038. OTS.

Data are summarized from a study on the uptake, distribution, retention, and biological effects in animals after administration, by various routes, of C^{14} in the forms of both inorganic and organic compounds. Studies with sodium bicarbonate-C^{14} showed that after intraperitoneal administration the biological half-life of this material was very short but that some entered the bone and the half-life of the bone-incorporated material was quite long. If very high levels were given, the radiation in specific areas of the bone might remain above permissible levels for more than a year. When $BaC^{14}O_3$ was administered as an aerosol, it was found that material was deposited in the lungs but that the biological half-life was short, presumably as a result of exchange of moist $BaC^{14}O_3$ with respiratory carbon dioxide. C^{14}-Labeled carbon black, administered intranasally, was deposited in the lungs, and such deposited material turned over only very slowly. Sodium formate-C^{14} was found to be taken up rapidly and preferentially by leukemic cells as compared with normal lymphocytes. However, injection of high levels into mice with leukemia had no effect on the patterns of death or on hematopoiesis. On the assumption that the biological site most sensitive to damage by C^{14} would be the genetic material (DNA), many experiments were carried out on the amount of C^{14} that was incorporated and retained in animal tissues after administration of C^{14}-labeled precursors of nucleic acids. When C^{14}-adenine or C^{14}-formate was administered to pregnant animals, the DNA of the embryonic tissues was highly labeled, and in the DNA of the brains and livers of the offspring, incorporated C^{14}, unchanged in quantity and distribution, was retained over a period of one year of observation and probably for the life of the animal. However, C^{14} thus administered produced no detectable somatic effects and no gross genetic damage insofar as the latter could be detected by fertility of the offspring and the absence of obvious abnormalities among the litters produced by the offspring. (auth)

4884 (TID-11071) FINAL REPORT [ON RADIUM UPTAKE]. (Kansas. Univ., Lawrence). [1960]. 32p. Project No. 2. Contract AT(11-1)-83. OTS.

Research evaluating the results of radium uptake by human beings is reported. One study involved sectioning and autoradiography of bones from deceased "dial painters." Special techniques had to be developed for this study. The results show that metabolically deposited radium is very nonuniform in distribution and concentrates at actively forming sites. Similarities in metabolism of Sr^{90} led to intensive studies with this isotope. Transmission of radium by lactation was studied, but animal weight changes affected the results. Therefore, a bremsstrahlung counting study was performed and a reevaluation of the effect of diet made. Other investigations are reported on malic acid reduction of deposition. (T.R.H.)

4885 (TID-11072) THE USE OF THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS. Progress Report [for Period] December 18,

1959–December 1, 1960. (Massachusetts. General Hospital, Boston). Dec. 1, 1960. 10p. Contract AT(30-1)-1093. OTS.

A summary of 1960 work is presented, and progress is reported for December in studies of blood-brain barrier, B compound for neutron-capture irradiation, calibration of medical facility at MIT Reactor, neutron-capture therapy at MIT Reactor, autoradiography of tritiated B compounds in tumor cells, hypophysectomy by neutron capture, radiotherapy of cephalic neoplasms by short-lived β emitters, ability of chelates to penetrate brain and brain tumors, and effect of B compounds on blood clotting. (T.R.H.)

4886 (TID-11074) FINAL TECHNICAL REPORT. Samuel Schwartz (Minnesota. Univ., Minneapolis). 1960. 14p. Contracts AT(11-1)-108 and AT(11-1)-644. OTS.

A summary is presented of the findings in an investigation of the effects of porphyrins on radiosensitivity. The project included synthesis and excretion of porphyrin in experimental and clinical conditions, chemical studies of hematoporphyrin and metalloporphyrins, localization of porphyrins in tissue, physiological effects of porphyrins, and modification of radiosensitivity by porphyrins. (T.R.H.)

4887 (TID-11075) THE RELATION OF PORPHYRIN STRUCTURE TO MODIFICATION OF X-RAY SENSITIVITY. Samuel Schwartz (Minnesota. Univ., Minneapolis). [1960]. 22p. OTS.

Presented at the Conference of Porphyrins, Atomic Energy Commission of France, Saclay, September 15-17, 1960.

A lecture is presented summarizing extensive research on relation of porphyrin structure to x-ray sensitivity. The research dealt with localization of porphyrins in tumors and other tissues, effects of porphyrins on x-ray sensitivity of tumors and other tissues, effects of porphyrins on chemotherapeutic agents, biochemical and physiological properties of porphyrins as related to the above effects, and chemical nature of the various porphyrins. (T.R.H.)

4888 (JPRS-5761) MEDICAL RADIOLOGY. Translation of Meditsinskaya Radiologiya, Volume V, No. 7, 1960. 299p. OTS.

4889 (JPRS-5761(p.59-68)) IMMEDIATE RESULTS OF TREATMENT OF VAGINAL SARCOMA IN DOGS WITH THE USE OF THE BETATRON. V. M. Lopushinskaya, G. T. Ishchenko, A. I. Volkova, and M. S. Samyshkin. Translated from Med. Radiol. 5, No. 7, 22-5(1960).

Betatron irradiation gave good results in the treatment of vaginal sarcoma in dogs. Irradiation techniques are described and results are discussed. (C.H.)

4890 (JPRS-5761(p.69-84)) CLINICAL-ELECTROCARDIOGRAPHIC CHANGES IN PATIENTS WITH THYROTOXICOSIS AFTER TREATMENT WITH RADIOACTIVE IODINE. E. I. Vasil'eva (Ye. I. Vasil'yeva) and I. D. Kucherova. Translated from Med. Radiol. 5, No. 7, 26-31 (1960).

Results are reported from an investigation of electrocardiographic changes in patients with thyrotoxicosis after treatment with I^{131}. (C.H.)

4891 (JPRS-5761(p.85-96)) THE SIGNIFICANCE OF SECONDARY RADIATION FROM FILTERS OF Co^{60} WHEN THEY ARE USED FOR INTRACAVITARY TREATMENT. A. A. Stankevich. Translated from Med. Radiol. 5, No. 7, 32-6(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23861.

4892 (JPRS-5761(p.149-60)) THE BEHAVIOR OF $Te^{127,129}$ IN THE ANIMAL ORGANISM. Yu. I. Moskalev. Translated from Med. Radiol. 5, No. 7, 54-9(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23885.

4893 (JPRS-5761(p.161-7)) THE PROTECTIVE EFFECT OF POTASSIUM IODIDE DURING THE CHRONIC INFLUX OF RADIOACTIVE IODINE INTO THE BODY. V. L. Shvedov. Translated from Med. Radiol. 5, No. 7, 60-2 (1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23886.

4894 (JPRS-5761(p.189-91)) THE COURSE OF EXPERIMENTAL TUBERCULOSIS UNDER CONDITIONS OF THE EFFECT OF RADIOACTIVE PHOSPHORUS. E. D. Dubovyi (Ye. D. Duboyy), L. B. Aksel'rod, N. D. Golban, A. A. Konshin, and E. P. Tsyban. Translated from Med. Radiol. 5, No. 7, 71(1960).

The immunological mechanisms in animals infected with tuberculosis were found to be greatly reduced after the administration of large doses of P^{32}. The administration of small doses of P^{32} caused a more favorable course of tuberculosis than that observed in controls. (C.H.)

4895 SENSITIVE STAGES FOR THE PRODUCTION OF DEVELOPMENTAL ABNORMALITIES IN MICE WITH 5-FLUOROURACIL. Charles P. Dagg (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Am. J. Anat. 106, No. 2, 89-96(1960) Mar.

Pregnant mice of the inbred strains, 129/Rr and BALB/cRr were given single intraperitoneal injections of 5-fluorouracil at 10, 11, 12, or 13 days after copulation. Polydactyly, macrodactyly, oligodactyly, syndactyly, hypodactyly, cleft palate, micrognathia, and deformities of the tail were produced in a large proportion of the fetuses. The type of induced deformity was dependent upon the time of treatment and the dosage. When several dosage levels were given, the incidence and severity of malformations were related to the intensity of treatment. The BALB/c embryos were less responsive than those of strain 129 to low doses of fluorouracil and, in general, the period of peak susceptibility to induction of foot defects occurred one day later in the BALB/c than in the 129 strain. The activity of 5-fluorouracil has been compared with that of other acute teratogenic treatments. (auth)

4896 USE OF X RAYS FOR IMPROVEMENT OF VETCH. L. Zannone (Università, Pavia, Italy). Atti assoc. genet. ital. 5, 149-59(1960). (In Italian)

Dry seeds (moisture content about 8%) were treated with doses of 5, 10, 20, and 25 kr in order to find out the optimal dose of x rays for a practical breeding program on vetch (V. sativa type 101/1 Foggia). Critical evaluation of the amount of somatic damage due to radiation treatment was done on the basis of the following criteria: seed germination, growth of roots, lack of abnormalities in the development of the roots, survival at 36 days after treatment, and survival at moment of ripening. Seed germination was not affected; no statistical correlation was demonstrable between lack of abnormalities in the development of the roots and treatment. The five experimental doses induced a reduction of the root length, which was, respectively, 91, 75, 69, 67, and 64% of the control. The LD_{50}, detected on the basis of survival at 36 days after treatment and survival at moment of ripening, is between 10 and 15 kr, probably around 12 kr. (auth)

4897 THE THRESHOLD DOSE OF P^{32} FOR LEUKEMIC CELLS OF THE LYMPHOCYTIC AND GRANULOCYTIC SERIES. Edwin E. Osgood (Univ. of Oregon Medical School, Portland). Blood 16, 1104-21(1960) Aug.

A study was made of the threshold dose of P^{32} for leuke-

mia patients. The analyses are based on the dose for 201 chronic lymphocytic leukemia patients and 100 chronic granulocytic leukemia patients to control leukocyte count and the dose to maintain 133 chronic lymphocytic patients 50.2 months and 49 chronic granulocytic patients 33.6 months. These threshold doses fit the logarithmic probability distributions given in the tables and figures. Revised recommendations on the dosage schedule for titrated, regularly spaced P^{32} therapy of the chronic leukemias are presented. (T.R.H.)

4898 STUDIES ON THE DISTRIBUTION OF Cs^{137} IN RATS. I. DISTRIBUTION OF Cs^{137} IN NORMAL RATS. Yasusi Nisiwaki (Tokyo Inst. of Tech.), Hirosi Kawai, Kazuo Matsumoto, Kazuhiko Mikota, Masako Yamada, Hirosige Morisima, and Tosiko Furukubo. J. Radiation Research (Japan) 1, 61-9(1960) June. (In English)

The authors studied the distribution of Cs^{137} in albino rats after the subcutaneous injection of Cs^{137}. The organs examined can be divided roughly, into two groups: one that reaches a maximum concentration at 1 hr after injection and the other that reaches a maximum rather slowly. Such organs as heart, lung, liver, stomach, intestine, kidney, and spleen were observed to belong to the first group and brain, testis, muscle, bone, and blood to the second group. The blood was rather peculiar in the sense that it reached a maximum concentration at 3 hr when the tissue concentration of most of the organs was observed to decrease. (auth)

4899 FLORA OF ENIWETOK ATOLL. Harold St. John (Chatham Coll., Pittsburgh). Pacific Sci. 14, 313-36 (1960) Oct.

After a brief discussion of the location, topography, size, and ecology of Flora, an account of the Flora of Eniwetok is presented. (T.R.H.)

4900 RADIOCARBON STUDIES ON THE TRANSLOCATION OF ORGANIC CONSTITUENTS INTO RIPENING TOMATO FRUITS. John P. McCollum (Univ. of Illinois, Urbana) and John Skok. Proc. Am. Soc. Hort. Sci. 75, 611-16(1960).

P^{32}-labeled phosphate applied to leaves or peduncles of tomato plants moved readily into fruits of all maturity stages, regardless of the relative position of leaf and fruit cluster. The movement of C^{14}-glucose applied to leaves, is governed largely by the vascular anatomy intervening between the site of application and the fruit. If the selected leaf is in the same vertical sector as the fruit, translocation paths for sugar are generally adequate. Under these circumstances, sugar applied to a leaf moved into green fruits and fruits at the turning stage, but not into ripe fruits. In the case of ripe fruit, sugar moved into the peduncle, past the mid-separation zone of the pedicel and up to the calyx, but not past the abscission layer between the calyx end of the pedicel and the fruit. The movement of labeled organic materials into fruits of various stages of maturity may best be determined by labeling the entire photosynthetic supply with $C^{14}O_2$. The products of photosynthesis moved most rapidly into the youngest ripe fruits that were developing rapidly and increasing in size. The rate of movement decreased as the green fruit developed further and reached a low point at the mature green stage when the fruit had attained full size. Activity again increased at the turning stage, indicating a rise in the movement of organic constituents into fruits at incipient coloration. Activity dropped as pigment formation and ripening progressed and became negligible when the fruit had attained the ripe stage. These results indicate that maximum quality of ripe tomatoes would not be impaired if they were harvested just prior to the full-ripe stage on the basis that most of the organic constituents supplied by the leaves had by this time entered the fruits. Such a procedure would take advantage of the reduction in high field losses which are sustained when harvesting is carried out at the full-ripe stage. The results further indicate that the quality of immaturely harvested fruits could be measurably improved if they were harvested when coloration began to appear rather than at the mature green stage as is normally practiced commercially in the green wrap industry. Most of the organic constituents have entered the fruit by about five days or so past the turning stage. (auth)

4901 THE HYPERFINE STRUCTURE OF THE HYDROGEN MOLECULAR ION. A. Dalgarno, T. N. L. Patterson, and W. B. Somerville (Queen's Univ., Belfast). Proc. Roy. Soc. (London) A259, 100-9(1960) Nov. 22.

A calculation is presented of the energy levels of the hydrogen molecular ion in the ground state for different orientations of the electron spin, considering the coupling of the electron spin to the nuclear spin and to the nuclear rotational angular momentum. The first-order coupling terms are evaluated to a very high accuracy, and quantitative results are given for the level splitting for a number of rotational levels. (auth)

4902 A NEW PROCEDURE FOR REPRESENTATION OF WEAKLY-STORING TISSUES IN GAMMA SCINTIGRAPHY. Dietrich Frost and Heinz Werkes (Städt. Rudolf-Virchow-Krankenhauses, Berlin). Strahlentherapie 113, 461-8(1960) Nov. (In German)

The scintigraphic plotting of weak activity storing tissues is almost impossible in the presence of a raised basic level of radiation of equal radiation energy. The radiation fields of normal tissue and pathological tissue differ from one another only a few percent, e.g., in the tumor localization with radioisotopes. These slight differences were through the impulse statistics again lessened and can no longer be presented by the usual linear method of registration. A registration method is described in which the registration signals depend no more as linear function of the impulse rate. The indication line of the presentation runs, after a bend, very steeply, whereby the bend can be moved. Through this it is possible to suppress the impulse rate of the basic level of radiation (level suppression) and to plot strongly overvalued utilized impulse rate corresponding to the indication line (contrast improvement). The methods have proved themselves especially in the localization of brain tumors. (auth)

4903 COLLOIDAL ZIRCONYL PHOSPHATE-P-32. R. J. Speer, J. E. Young, J. M. Hill, and E. Loeb (J. K. and Susie L. Wadley Research Inst. and Blood Bank, Dallas, Tex. and Baylor Univ. Hospital, Dallas, Tex.). p.1403-8 of "The International Society of Hematology; Proceedings of the Seventh Congress, Rome, September 7-13, 1958. Volume II, 2nd Part. Communications." New York, Grune & Stratton, 1960.

The preparation, tissue distribution, and clinical applications of zirconyl phosphate, labeled with P^{32}, are described. (C.H.)

Biochemistry, Nutrition, and Toxicology

4904 VERTEBRATE RADIOBIOLOGY: METABOLISM OF INTERNAL EMITTERS. Roy C. Thompson

(General Electric Co., Richland, Wash.). Ann. Rev. Nuclear Sci. 10, 531-60(1960). (HW-SA-1900)

A survey is presented of literature pertaining to the metabolism of internal emitters. Radiation damage from internal emitters is not considered, except to the extent that studies in this area may be cited to support the significance of, or need for, information of a metabolic nature. Preference is given to the more comprehensive and accessible references without regard to historical precedence. Studies in the fields of industrial toxicology and mineral nutrition contribute a very extensive background of information often pertinent to problems of internal emitter hazards. General considerations pertinent to all radioisotopes or to substantial groups of radioisotopes are discussed, followed by a review of the metabolism of specific radioelements. 224 references. (B.O.G.)

4905 STUDY OF THE PERMEABILITY OF THE VARIOUS PARTS OF THE TUBULES TO SODIUM AND POTASSIUM IONS. F. Morel and A. Falbriard (Commissariat à l'Énergie Atomique, Saclay, France). Rev. franç. études clin. et biol. 4, 471-4(1959). (In French). (CEA-1287)

The method of stop flow analysis was used in rabbits together with radioactive sodium and potassium injected in the middle of a six-minute period of arrest of urine flow during an osmotic diuresis. Urine was subsequently collected in 60 to 80 mg samples. The specific activities of sodium and potassium suggest that both ions pass directly from the renal interstitial tissue into the urine at different and distinct areas in the tubules. The whole distal segment, including the area of active reabsorption of this ion, is impermeable to sodium in the direction interstitial tissue to lumen. The adjacent, more proximal tubule is, however, extremely permeable. The distal tubular impermeability to potassium is more limited, the specific activity already having reached a maximum at the level of active sodium reabsorption. (auth)

Fallout and Ecology

4906 ON THE PREVISION OF THE ACCUMULATION IN SOIL AND IN CROPS OF LONG LIVED RADIOISOTOPES SUPPLIED OVER AN UNLIMITED PERIOD AT A GIVEN RATE. G. Barbier, F. Huguet, G. Michon, and E. Tyszkiewicz. Compt. rend. acad. agr. France 44, (No. 18) 874-80 (1958). (In French). (CEA-1142)

Cultural experiments were performed in the field in order to determine the radioactive contamination of various plant species. The method was based on the determination of the accumulation in the soil and the determination of an empirical factor c defined as follows: c = (amount of radioisotope taken up per unit of harvested product/amount of radioisotope per soil unit). By this method the maximum contamination of various plants irrigated with water of known contamination supplied over an unlimited period at a constant rate could be calculated. (auth)

4907 ACCUMULATION OF RADIOACTIVE MATERIALS BY FISHERY ORGANISMS. Walter A. Chipman (U. S. Fish and Wildlife Service). p.97-110 of "Proceedings of the Gulf and Caribbean Fisheries Institute, Eleventh Annual Session, November 1958." [Coral Gables, Fla.,] University of Miami. (A/AC.82/G/L.468)

A discussion is presented of the accumulation of radioactivity by marine fish and shellfish from sea water contaminated by fission products. Data are presented from experiments with a wide variety of isotopes involving plankton, oysters, clams, scallops, bluefish, croakers, mullet, and killifish. (T.R.H.)

Radiation Effects on Living Tissues

4908 (A/AC.82/R.109) RADIATION EFFECTS IN EMBRYOS AND FOETUSES. (United Nations. Secretariat). Sept. 13, 1960. 39p.

The exposure of embryos to ionizing radiation brings about profound disturbances in development, which range from minor deformities to early death. The susceptibility of embryos to radiation is very high, even though perhaps no higher than is the susceptibility of some actively dividing and differentiating adult tissues. Irradiation of an embryo with 5 to 25 r causes evident changes, but an exposure of adult hemopoietic tissues or epithelial tissues to the same range of doses is also followed by marked morphological and functional disturbances. The difference between embryonic and adult response to low doses of radiation is that an over-all effect in embryos is much more extensive than in an adult organism. This may well be due to the fact that even a minor irreversible injury in an embryo, particularly if it occurs after the blastomeres have lost their totipotency, is likely to become amplified in the course of development: somatic mutation may be propagated in succeeding generations of cells, necrotic areas may be overgrown by surrounding tissues, etc. A detailed analysis of radiation effects in embryos is complicated by the fact that at least two different mechanisms may be operating at the same time: developmental alterations in the embryo and physiological disturbances in the maternal organism. In some experiments a third factor has to be taken into account, namely, radiation injury to parental gametes incurred prior to fertilization. Developmental aberrations, and to a lesser degree, physiological disturbances in maternal organism are discussed in detail. Studies on the effects of irradiation of prefertilization gametes are treated to a very limited extent, mainly in connection with the problem of radiation effects upon fertilization. 89 references. (auth)

4909 (AMRL-452) ELECTROPHORETIC MOBILITY AND ANTIGENICITY OF X-IRRADIATED HUMAN SERUM GAMMA GLOBULIN. Anthony J. Luzzio (Army Medical Research Lab., Fort Knox, Ky.). Sept. 27, 1960. 14p. Project No. 6X64-14-001-01.

Exposure of human serum gamma globulin (HSGG) to various doses of x rays results in the production of molecules electrophoretically distinct from the parent protein. The evidence that structural changes take place is given support by the finding that the antigenic specificity of the new derivative is far removed from that of the starting material. It is suggested that HSGG denatured by ionizing rays has definite and controllable characteristics. (auth)

4910 (BNL-4957-R) A DEMYELINATING OR MALACIC MYELOPATHY IN EXPERIMENTAL RATS AS A DELAYED EFFECT OF LOCALISED X-IRRADIATION. J. R. M. Innes and A. Carsten (Brookhaven National Lab., Upton, N. Y.). [1960]. 25p. OTS.

Preliminary results are summarized from a study of delayed pathological effects following exposure of the upper body and vertebral column of rats to x radiation. Data are also included from observations on two monkeys. Injury corresponded in regional distribution to the irradiated area of the body. A severe type of myodegeneration and necrosis of the vertebral skeletal muscles in the same area as the spinal cord damage was almost a constant concomitant finding. Clinical symptoms and histological findings are described. (C.H.)

4911 (LAMS-2455(p.145-8)) THE INHERITANCE OF RADIATION-INDUCED MUTATIONS DELETERIOUS TO THE REPRODUCTIVE EFFICIENCY IN THE MOUSE. PART I. THE REPRODUCTIVE PERFORMANCE OF THE SIXTH FILIAL GENERATION FROM FIVE GENERATIONS OF X-IRRADIATED MALE MICE. J. F. Spalding and V. G. Strang (Los Alamos Scientific Lab., N. Mex.).

Observations are reported on the reproductive performance and life span of the sixth filial generation from five generations of x-irradiated male mice. It was concluded that 200 rads of x radiation, delivered to the male mouse for five consecutive generations, resulted in heritable genetic damage to the unexposed F_6 generation. (C.H.)

4912 (LAMS-2455(p.145-51)) THE INHERITANCE OF RADIATION-INDUCED MUTATIONS DELETERIOUS TO THE REPRODUCTIVE EFFICIENCY IN THE MOUSE. PART II. THE REPRODUCTIVE PERFORMANCE OF THE ELEVENTH FILIAL GENERATION FROM TEN GENERATIONS OF X-IRRADIATED MALE MICE. J. F. Spalding and V. G. Strang (Los Alamos Scientific Lab., N. Mex.).

Progress is reported in studies on the inheritance of radioinduced mutations, reproductive performance, resistance to nonspecific stress, and life span of the eleventh filial generation from 10 generations of x-irradiated mice. (C.H.)

4913 (LAMS-2455(p.158-62)) COMPARISON OF NATURAL AND RADIATION AGING MECHANISMS: RESPONSE OF IRRADIATED AND NONIRRADIATED MICE TO COLD STRESS. T. T. Trujillo and J. F. Spalding (Los Alamos Scientific Lab., N. Mex.).

The response of radiation-aged mice was found to be similar to the response of naturally-aged mice to nonspecific stress such as cold. (C.H.)

4914 (LAMS-2455(p.163-6)) EFFECT OF PREIRRADIATION TREATMENT WITH GLUTATHIONE ON THE AGE SPECIFIC LOG RATES OF MORTALITY (GOMPERTZ FUNCTION). I. U. Boone, G. A. Trafton, and L. M. Conklin (Los Alamos Scientific Lab., N. Mex.).

Results are summarized from a study of the effects in mice of pretreatment with glutathione prior to a single lethal or sublethal exposure to x radiation. (C.H.)

4915 (LAMS-2455(p.167-74)) EFFECTS OF SUBLETHAL WHOLE BODY X IRRADIATION AT DIFFERENT AGE LEVELS IN CF_1 MICE. I. U. Boone, G. A. Trafton, and L. M. Conklin (Los Alamos Scientific Lab., N. Mex.).

Results are reported from a study of the effects of exposure of mice to chronic sublethal whole-body x radiation as a function of age at time of exposure. Data are presented graphically. (C.H.)

4916 (LAMS-2455(p.175-80)) EFFECT OF SINGLE SUBLETHAL DOSES OF NITROGEN MUSTARD (HN_2) ON THE AGE SPECIFIC LOG RATES OF MORTALITY (GOMPERTZ FUNCTION) AS COMPARED TO WHOLE BODY X IRRADIATION. I. U. Boone, G. A. Trafton, and L. M. Conklin (Los Alamos Scientific Lab., N. Mex.).

Results are reported from an investigation of the long-term and delayed effects of nitrogen mustard (HN_2), a known chemical mutagen, as compared to whole-body x irradiation in mice. Data are presented graphically on age specific rates of mortality for mice following administration of a single dose of nitrogen mustard or x irradiation. (C.H.)

4917 (LAMS-2455(p.181-5)) RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF VARIOUS IONIZING RADIATIONS ON THE TRANSFORMING PRINCIPLE (DNA) OF HEMOPHILUS INFLUENZAE. I. U. Boone and J. A. Sayeg (Los Alamos Scientific Lab., N. Mex.).

Results are reported from preliminary investigations of the effects of various ionizing radiations on solutions of transforming desoxyribonucleic acid of Hemophilus influenza. Data are tabulated on the relative biological effectiveness of Co^{60} gamma rays, 250 kvp x rays, 14 Mev neutrons, and Godiva degraded fission neutrons on this test system. (C.H.)

4918 (LAMS-2455(p.199-201)) GIANT CELL FORMATION IN HeLa CELLS AS A FUNCTION OF COBALT^{60} GAMMA RAYS AND X IRRADIATION. II. EFFECT OF VARIABLE DOSE RATES. D. C. White and P. C. Sanders (Los Alamos Scientific Lab., N. Mex.).

The giant cells formed in HeLa cell cultures were correlated with the total dose of Co^{60} gamma radiation and x radiation given at varying dose rates. Data are tabulated. (C.H.)

4919 (LAMS-2455(p.202-5)) EFFECT OF COBALT^{60} GAMMA RAYS, X RAYS, AND FAST NEUTRONS ON TOTAL CELL POPULATION OF HeLa CELLS IN TISSUE CULTURE. D. C. White and P. C. Sanders (Los Alamos Scientific Lab., N. Mex.).

The effects of gamma, x radiation, and fast neutrons were compared in HeLa cell cultures. Data are tabulated on cell growth and giant cell formation after exposure to various dosages. (C.H.)

4920 (ORO-338) RESEARCH ON DIRECT AND INDIRECT EFFECTS OF RADIATION ON THE GENETIC SYSTEMS OF ORGANISMS. Final Report covering the Period June 29, 1951–August 31, 1960. W. S. Stone (Texas. Univ., Austin). Oct. 20, 1960. 12p. Contract AT(40-1)-1323. OTS.

Research is reported on genetic damage by radiation to populations and their recovery or death and on reduction or enhancement of radiation damage. Attempts at finding a suitable population for study are described, and studies of populations at the Pacific Proving Grounds are reported. In another study the effects of ultraviolet x rays, neutrons, and α particles were compared. Differences in sensitivity in various atmospheres were also studied. (T.R.H.)

4921 (TID-11206) PROGRESS REPORT. I. X-RADIATION PROTECTION BY CHEMICAL AGENTS IN GUINEA PIGS. II. X-RADIATION EFFECT ON THE NUCLEIC ACIDS AND THEIR DERIVATIVES IN LEUCOCYTES AND BLOOD PLATELETS OF HORSE BLOOD IN VITRO. Richard Wagner (Tufts Univ., Boston. School of Medicine). Dec. 1960. 3p. Contract AT(30-1)-1673. OTS.

The protective effects of glutathione against the effects of 200 r x radiation in guinea pigs were studied in a large number of animals. Results indicate that glutathione concentration in the erythrocytes and the ability to protect reduced glutathione in the irradiated and protected animals are related to activity of glucose 6-phosphate dehydrogenase. Studies were continued on the effects of x radiation on nucleic acids and their derivatives in horse-blood leukocytes and blood platelets. Preliminary results indicate that the adenine concentration exceeds that of guanine, in contrast to the findings on whole cells. (C.H.)

4922 (TID-11221) THE EFFECTS OF X-RADIATION ON WORK CAPACITY AND LONGEVITY OF THE DOG. Ninth Annual Progress Report, 1960. (California. Univ., Davis. School of Veterinary Medicine). June 1960. 137p. Project No. 4. Contract AT-11-1-GEN-10. OTS.

The status of the kennel remains excellent. During the

past year, the employment of a full-time veterinarian has made possible more constant surveillance of the aging dogs. The routine semi-monthly examination of the dogs has revealed that irradiated and control dogs gain equally (6.6 oz per 100 day period) in body weight with advancing age. The only substantial evidence of accelerated aging among the irradiated dogs has been in the rhythmic occurrence of estrus. Female beagles exposed to 300 r have an extended anestrous period after 1500 days or 4 years of age. Over one-half of the 300 r dogs had one or more anestrous periods exceeding 500 days; this is normal in beagles only after they attain 8 years of age. Even median lethal doses of fast neutrons failed to sterilize female beagles. Since no evidence has been found to show that whole-body irradiation causes sterility in the dog, it is speculated that these results are related to nonspecific aging phenomena. However, the possibility of endocrine dysfunction in 11 dogs by an endometrial transplant into the anterior chamber of each eye is being investigated. Evaluations of accumulated hematological data have further emphasized the importance of base line information. Fluctuation in normal blood values of dogs has not been sufficiently investigated to permit a valid conclusion with regard to possible long-term effects of irradiation. Correction for seasonal and gestational variation has shown Pollock's Trichrome Stain (PCV) characterics of histological sections and red blood cell counts (RBC) do not increase concurrently with age. Rather, after 1100 days of age, the PCV values continue to rise while the RBC values decline. A possible explanation for this observation is a change in size and number of erythrocytes with age. Although parabolic equations differed for RBC's between 0, 100, and 300 r groups, further analyses are required to establish confidence limits before a valid conclusion can be made. Biochemical fractionation for investigation of the intravascular polysaccharide identified in dogs and pigs dying from acute radiation is continuing. An increased incidence of radiation-induced cancers has been observed in dogs during the past year. Malignant adenocarcinomas of the ovaries as well as carcinomas of the pancreas and liver occurred in the 100 and 300 r groups after a lag period between 1500 and 2000 days. Despite radiation induced neoplasms and other causes of death, beagles under natural conditions continue to die earlier than the experimental dogs. It can be assumed that a true picture of radiation effects will be known since the experimental dogs can live out their life span. (auth)

4923 (USNRDL-TR-470) RENAL NEOPLASMS IN THE IRRADIATED AND NON-IRRADIATED SPRAGUE-DAWLEY RAT. V. J. Rosen, T. J. Castanera, D. R. Kimeldorf, and D. C. Jones (Naval Radiological Defense Lab., San Francisco). Oct. 11, 1960. 20p.

During a study of the long-term effects of ionizing radiation, a large number of animals with renal neoplasms was found. Seventeen (40%) of 42 rats receiving 430 rads and seventeen (29%) of 58 rats receiving 680 rads had renal tumors at autopsy. None were observed in nonirradiated controls derived from the same litters. The tumors were diagnosed as adenomas, carcinomas, and transitional cell carcinomas. It appears that x irradiation exerts a carcinogenic effect on the kidney, which is rarely the site of neoplasia in the non-irradiated rat. The findings suggest that, with respect to primary renal tumors in the rat, it is not useful to regard radiation exposure as a treatment resulting in an acceleration of normal aging processes. (auth)

4924 (JPRS-5761(p.23-33)) BONE MARROW HEMATOPOIESIS IN THE CHRONIC EFFECT OF SMALL DOSES OF IONIZING RADIATION. V. V. Sokolov and I. A. Gribova. Translated from Med. Radiol. 5, No. 7, 10-13 (1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23966.

4925 (JPRS-5761(p.34-50)) THE EFFECT OF Cs^{137} ON THE HUMAN BODY. M. N. Fateeva (Fateyeva), V. S. Klimov, A. I. Ponizovskaya, N. I. Gorbarenko, V. V. Sokolov, and M. I. Smirnova. Med. Radiol. 5, No. 7, 14-19 (1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23967.

4926 (JPRS-5761(51-8)) CASE OF LAG OF GROWTH OF FOREARM BONES IN A GIRL AFTER RADIOTHERAPY FOR A SKIN HEMANGIOMA. T. D. Mirimova. Med. Radiol. 5, No. 7, 19-21(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23968.

4927 (JPRS-5761(p.97-109)) EXPERIMENTAL ANALYSIS OF THE CONDITION OF THE THYROID GLAND IN CHRONIC TOTAL-BODY IRRADIATION. E. (Ye.) A. Lyalin. Translated from Med. Radiol. 5, No. 7, 37-41 (1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23969.

4928 (JPRS-5761(p.122-36)) THE EFFECT OF RADIATION ON THE VITAMIN B_1 METABOLISM. Iori Ueno. Translated from Med. Radiol. 5, No. 7, 45-51(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23971.

4929 (JPRS-5761(p.137-48)) CLARIFICATION OF THE CHEMICAL NATURE OF PEROXIDE COMPOUNDS FORMED DURING THE COURSE OF ACTION OF THE RADIATION FACTOR. E. (Ye.) M. Pandre. Translated from Med. Radiol. 5, No. 7, 51-4(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23972.

4930 (JPRS-5761(p.168-77)) SENSITIVITY OF ANIMALS TO INFECTION WITH A CULTURE AND TOXIN OF THE BACILLUS PERFRINGENS AND THE EFFECTIVENESS OF TOXOID IMMUNIZATION UNDER CONDITIONS OF RADIATION INJURY. L. M. Shmuter. Translated from Med. Radiol. 5, No. 7, 63-6(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23973.

4931 (JPRS-5761(p.242-4)) EARLY MORPHOLOGICAL CHANGES OF THE GASTROINTESTINAL TRACT AFTER INJURY BY RADIOACTIVE STRONTIUM. G. A. Lebedeva. Translated from Med. Radiol. 5, No. 7, 85 (1960).

Results are reported from an investigation of the early morphological changes of the gastrointestinal tract in acute radiation sickness produced by the intravenous injection of 1.5 microcuries per gram of Sr^{90} in rats. (C.H.)

4932 (JPRS-5761(p.245-50)) THE EFFECT OF LOCAL AND TOTAL-BODY X-IRRADIATION ON THE PERMEABILITY OF THE BLOOD VESSELS OF THE ANTERIOR PORTION OF THE EYE. E. G. Mikheeva (Ye. G. Mikheyeva). Translated from Med. Radiol. 5, No. 7, 85-7 (1960).

Results are reported from a study of the effect of various doses of local and whole-body x irradiation on the permeability of the blood vessels of the anterior segment of the eye in rabbits. An attempt was made to elucidate the role

of the nervous system in the changes in permeability occurring after irradiation. (C.H.)

4933 (JPRS-5761(p.251-7)) THE EFFECT OF HYPERTHYROIDISM ON THE CONTENT OF SH-GROUPS IN SOLUBLE PROTEINS OF THE LIVER AND THE SURVIVAL RATE OF RATS AFTER IRRADIATION WITH X-RAYS. E. (Ye.) M. Kedrova and Zh. A. Antokol'skaya. Translated from Med. Radiol. 5, No. 7, 87-8(1960).

Results are reported from a study of the effect of hyperthyroidism on the content of SH-groups in soluble proteins of the liver and the survival rate of rats after exposure to x radiation. (C.H.)

4934 (JPRS-5761(p.258-63)) THE ACTIVITY OF THE FALSE AND TRUE CHOLINESTERASE OF IRRADIATED ANIMALS. R. N. Shastin, F. Kh. Kucheryavyy, and T. V. Krantikova. Translated from Med. Radiol. 5, No. 7, 88-9 (1960).

Results are reported from a study of the effects of ionizing radiation on changes in blood serum levels of false and true cholinesterase in rats. The changes in the activity of pseudocholinesterase and true cholinesterase at various periods of acute lethal radiation sickness were attributed to the presence of serious disturbances in acetylcholine metabolism. It is suggested that the reduction of cholinesterase activity of the blood serum can serve as an additional test for the early diagnosis of radiation injury. (C.H.)

4935 (JPRS-7263) VARIATION OF MICROORGANISMS UNDER THE INFLUENCE OF IONIZING RADIATION. (Minlyvist' Mikroorganizmiv pid Vplyvom Ionizuyuchykh Vyprominyuvan'). A. M. Pasichnyk. Translated from Mikrobiol. Zhur., Akad. Nauk Ukr. R.S.R., Inst. Mikrobiol. im. D. K. Zabolotnogo 22, No. 3, 69-74(1960). 13p. OTS.

Data are summarized from a literature review on the influence of radiation on variation in microorganisms. 55 references. (C.H.)

4936 EFFECT OF TOTAL BODY GAMMA RADIATION ON VITAMIN B_{12} CONTENT OF TISSUE OF IRRADIATED RATS. Victor P. Bond, Helen R. Skeggs, Gloria D. E. MacRae, Lemual D. Wright, Charles Rosenblum, and Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y. and Merck Sharp and Dohme Research Labs., Rahway, N. J.). Acta Med. Scand. 168, No. 2, 103-4(1960). (In English). (BNL--4701)

Rats were exposed to 900 r of γ radiation, and the Vitamin B_{12} content of serum, liver, and spleen was determined. Exposure to this level of radiation did not alter significantly the Vitamin B_{12} concentration of the tissues investigated. A significant decrease in the total amount of Vitamin B_{12} in the spleen was accompanied by a marked atrophy of that organ. (auth)

4937 CELLULAR RADIOBIOLOGY. Tikvah Alper (Hammersmith Hospital, London). Ann. Rev. Nuclear Sci. 10, 489-530(1960).

A survey is given of literature pertaining to cellular radiobiology. In order to deal adequately with the great volume of relevant literature, it was necessary to interpret the title literally. Little consideration was given to the radiation chemistry of biological molecules or to radiation effects on viruses and other subcellular units. Investigations carried out with ultraviolet are referred to only insofar as they have an obvious bearing on effects of ionizing radiation. Discussions are included on electron spin resonance; dose-effect relationships; radiations of different quality; modification of radiation response by treatment before or during irradiation; modification of damage by treatment after irradiation; biochemical investigations; and evidence and speculations on radiobiological mechanisms. 224 references. (B.O.G.)

4938 VERTEBRATE RADIOBIOLOGY: LATE EFFECTS. J. B. Storer (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.) and D. Grahn. Ann. Rev. Nuclear Sci. 10, 561-82(1960).

A survey was made of recent data on the late effects of ionizing radiations on man and experimental animals. Topics discussed include life shortening and induction of leukemia, genetic defects, congenital abnormalities, and neonatal death. 163 references. (B.O.G.)

4939 NATURE OF THE DOMINANT LETHALITY INDUCED BY RADIATION. R. C. Von Borstel (Oak Ridge National Lab., Tenn. and Università, Pavia, Italy). Atti assoc. genet. ital. 5, 35-50(1960). (In Italian)

In the wasp Habrobracon it was found that radiation-induced dominant lethality is a complex consisting of at least three types distinguished phenotypically and genotypically. In Drosophila, two types are phenotypically distinguishable. By comparing radiation-induced with genetically contrived dominant lethality, it is possible to show that one of the three types of dominant lethality can be attributed to chromosome imbalance and that another type is possibly caused by chromosome loss or severe chromosome imbalance. The most common type of dominant lethality appears to be caused by excessive depression of the mitotic rate. The slowing of the rate of mitosis does not appear to be caused by inactivation of the nucleolus or nucleolus organizer but can be brought on by induction of the breakage-fusion-bridge cycle. It is possible that any other action of radiation that depresses the mitotic rate also will induce this type of dominant lethality. (auth)

4940 GENETIC DAMAGE IN SEEDS OF MAIZE TREATED WITH X-RAYS AND WITH NEUTRONS UNDER DIFFERENT PHYSIOLOGICAL CONDITIONS. A. Bianchi (Università, Milan). Atti assoc. genet. ital. 5, 137-48 (1960). (In English)

Curtis et al. have demonstrated that in barley the physiological effects of x-ray and neutron treatments on dormant seeds may be significantly altered by varying the moisture content of the seeds or their storage after treatment. Somewhat similar treatments were repeated on seeds of maize heterozygous for alleles of the yg_2 locus. Somatic sectors, representing loss or inactivation of the dominant allele, provide a criterion of genetic change in the short arm of chromosome 9. The scoring of the fifth leaf of the seedlings that were sprouted from the irradiated seeds for yellow-green streaks in green background was recorded. The water content of the treated seeds was about 6 to 13 and 26 to 32%, respectively. The planting times were from a few minutes after treatment up to weeks. Under such experimental conditions, no great differences were observed. (auth)

4941 EFFECTS OF TREATMENT WITH X RAYS ON SPECIES OF GRAIN WITH VARIOUS PLOIDIES. D. L. Palenzona (Università, Pavia, Italy). Atti assoc. genet. ital. 5, 161-74(1960). (In Italian)

Research carried out by Schwartz, Moutschen et al., on maize, barley, and hexaploid wheat has made evident the fact that some traits, after a point of maximum sensitivity to radiation (at different doses, according to the trait and the plant species studied) show a diminution of radiosensitivity, which has been called "reversal phenomenon." Schwartz postulated that the point of maximum radiosensitivity at low doses can be attributed to chromosome breakage that induces death by aneuploidy and that the diminution

of radiosensitivity at high doses is caused by an inhibition of mitosis. With the goal of studying the behavior of species of different degrees of ploidy belonging to the same genus, three species of wheat, T. monococcum (diploid), T. durum (tetraploid), T. vulgare (hexaploid), were treated with x rays up to 240,000 r. The degree of humidity of the seeds at the time of radiation was 5 and 13%. It was possible to identify, on the basis of the data obtained, the influence of the degree of ploidy and the degree of humidity, the trait considered on radiosensitivity in general and on the manifestation of the reversal phenomenon. The results obtained show that the effects of high doses of ionizing radiation have a fairly complex determination. Examination of the behavior of certain characters such as the dry weight of the seedlings, which gives an indication of the metabolic activity of the irradiated material, suggests that the reversal phenomenon might also include an inhibition of the autocatalytic activity (reduplication) of the hereditary material while the heterocatalytic activity (gene function) remains undamaged. At even higher doses, this latter activity would also be inhibited, and radiation death would occur. For greater clarity of the mechanisms of the effects of high doses of ionizing radiations, other experiments are planned which forsee the use of chemical and physical modification of radiosensitivity. (auth)

4942 GENETIC RESEARCH ON QUANTITATIVE CHARACTERS IN NICOTIANA. NOTE IV. EFFECTS OF X-RAY TREATMENT OF SEED ON THE VARIABILITY OF SOME FLOWERING CHARACTERISTICS. G. Wittmer (Istituto Scientifico Sperimentale per i Tabacchi, Rome). Atti assoc. genet. ital. 5, 175-82(1960). (In Italian)

In order to control the possibility of inducing mutations for polygenic systems in Nicotiana by ionizing radiations, seeds of five strains of N. tabacum were treated with three different doses (9048, 18096, 36192 r) of x rays; on the plants X_1, derived from seed irradiated with I and II dose (the highest dose was found to be lethal), a study on variability of six flower traits, which are polygenic traits that limit environmental influence, was started. The studied flower part dimensions were the following ones: throat width, limb width, basis of the longest lobe, length of the longest lobe, corolla length, distance between corolla basis, and the point where the corolline tube becomes wider. The results of the statistical analysis show that in the main, the lower dose (9048 r) does not induce variations statistically significant compared with the control, whereas the differences between dose 18096 r and the control are significant for several traits in several strains. There is always interaction between strains and doses; for one trait (the distance between the corolla basis and the point where the corolline tube becomes wider), the variation of the average value from the control is significant in all the irradiated strains. In one strain, T. 19 cultivar Virginia Bright, all the studied flower traits showed a variation that was always significant from the control. These factors may be considered the direct effects of x rays; the analysis of the second generation (X_2) and the following ones will provide indications about the genetic effects. (auth)

4943 EFFECT OF X-RAYS ON NUCLEIC ACID ISOLATED FROM TOBACCO MOSAIC VIRUS. J. A. Wohlhieter, A. Buzzell, and M. A. Lauffer (Univ. of Pittsburgh). Biochim. et Biophys. Acta 43, 163-72(1960). (In English)

Breakage of RNA, x-irradiated after phenol extraction from tobacco mosaic virus, was measured by using the ultracentrifuge equipped with u.v. absorption optics. The sedimentation patterns of control solutions of RNA show a homogeneous component corresponding in size to the fraction of monomer in the parent virus. Reproducible values for the 37% survival dose, D_0, for breakage of the main chain can be obtained by following the decrease of this RNA component with increasing x-ray dose. The indirect action of radiation was minimized by irradiating RNA in concentrated, oxygen-free, frozen solution. Under these conditions the D_0 for breakage was 21×10^5 R, whereas D_0 for dried RNA was 4.2×10^5 R and, for RNA in the virus, 4.0×10^5 R. The anomaly could be due to intramolecular hydrogen bonding since heating the irradiated RNA solutions to 65 or 70°C drastically increased breakage leading to an effective D_0 of 4.4×10^5 R. (auth)

4944 MECHANISM OF CONVULSIVE CRISES PRODUCED BY IRRADIATION OF THE HEAD OF RABBITS. Jean Cheymol, Jacques Dalion, Monique, and Claude Adolphe (Faculty of Medicine, Paris). Bull. acad. natl. méd. (Paris) (3) 144, 11-19(1960). (In French)

Experiments are described which were performed to determine whether convulsive crises in rabbits with irradiated heads are epileptic or hypocalcemic tetany. Blood calcium was followed in rabbits, some irradiated on the head only, some receiving whole-body irradiation, and a third group irradiated on a portion of the body having a surface area equal to the head. A histological study was also made of the different organs of these animals. (T.R.H.)

4945 THE STUDY OF THE EFFECT OF IONIZED RADIATION UPON THE LARVAE OF TRICHINELLA. N. P. Shikhobalova, Ya. L. Shekhtman, and E. Karmanova (All-Union Inst. of Helminthology, USSR). Byull. Nauch. Tekh. Inform. Vsesoyuz. Inst. Gel'mintol. 23-6(1957).

Results are summarized from a study of the effects of various radiation dosages on the development of Trichinella larvae. (C.H.)

4946 THE EFFECT OF INTRAUTERINE IRRADIATION UPON THE MORPHOLOGICAL AND HEMATOLOGICAL CHANGES, THE INTERRELATIONSHIP OF SEXES AND THE BODY WEIGHT OF RATS DEPENDING UPON THE STAGE OF THEIR DEVELOPMENT AT THE TIME OF IRRADIATION. Alena Lengerova. Ceskoslov. biol. 6, 321-9(1957).

When living young rats were examined after the pregnant mothers were irradiated, changes in their peripheral blood which would indicate impairments effected by radiation were not found. Deviations of the 1:1 head index are not statistically reliable and cannot therefore serve as indicators of the radiation's effect upon sex differentiation or upon the differentiation in the sensitivity to radiation of the two sexes. The maximum deviation from the normal weight effected by radiation is observed in young rats, the mother of which was treated with x rays on the 13th day of pregnancy. This deviation does not coincide with the maximum effect of lethal radiation. (Referat. Zhur. Biol. No. 4, 1959, Abstract No. 14379.)

4947 IONIZING RADIATION EFFECTS ON MATURING AND HARVEST OF COTTON. D. M. Guseĭnov and R. E. Eyubov (Inst. of Agronomy and Soil Studies, Azerbaidzhan, SSR). Doklady Akad. Nauk Azerbaidzhan. S.S.R. 15, 713-17(1959). (In Russian)

The results of 3-year tests carried out under hot-house and field conditions indicate that small amounts of Sr^{90} and Co^{60} salts improve cotton harvest and speed up maturing and opening of cotton bolls. (R.V.J.)

4948 A STUDY OF THE MECHANISM OF THE RADIOPROTECTION EFFECT OF CERTAIN SULPHUR

CONTAINING SUBSTANCES. E. Ya. Graevskiĭ and M. M. Konstantinova (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 969-72(1960) Aug. 1. (In Russian)

The protective effects of sulfur-containing compounds are correlated with their influence on the increase of oxygen. Experiments were carried out with white mice 8 to 12 weeks old, weighing 18 to 22 g. Prophylactic effects and oxygen intensity were studied in the liver and spleen at various intervals following the injection of 3 mg of cysteamine, 5 mg of cystamine, 10 mg of 2-amino ethylisothiuronium Br · HBr, 3.5 mg of 2-amino-5 isothiuroniummethylthiazoline Br · HBr, 20 mg of cysteine, HCl, and 25 mg of SH glutathione. The animals were exposed to single whole-body irradiations of 900 r at 378 r/min at 15, 30, 60, and 120 min following the injection. It is postulated that the "oxygen effect" is not necessarily related to water radiolysis but may result from potential radiation induced disturbances which appear only during molecular oxygen oxidation. Hence, in such cases the protection of sulfur-containing substances is expressed in the prevention of molecular oxygen oxidation. (R.V.J.)

4949 BIOLOGICAL EFFECTIVENESS OF C^{14} WHEN INCORPORATED IN LIVING STRUCTURES. A. M. Kuzin, B. M. Issev, V. V. Khvostova, V. I. Tokarskaya, and Yu. I. Bregadze (Inst. of Biological Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 134, 951-4 (1960) Oct. 1. (In Russian)

Biological effects of C^{14} incorporated into the cell structure were quantitatively correlated to the effects of Co^{60} γ radiation in 10-day vicia faba plants. The percentage of cells with chromosome aberrations was used as the criterion of biological effects. The data show 9 to 25 fold stronger mutation effects from C^{14} at identical absorbed energies. It is postulated that a considerable fraction of the mutations results from transformation effects, i.e., by $C^{14} \rightarrow N^{14}$ and by the special geometry of radioactive carbon incorporation. (R.V.J.)

4950 CHANGES IN ABSORPTION SPECTRA OF CEREBROSPINAL LIQUOR, TAKING PLACE UNDER THE INFLUENCE OF IONIZING RADIATION. L. B. Utevskaya (Inst. of Biological Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 134, 959-62(1960) Oct. 1. (In Russian)

Changes in cerebrospinal liquor absorption spectra following whole-body irradiation were studied in rabbits exposed to single γ-ray (Co^{60}) irradiations of 800 to 1000 r at 160 r/min. The cerebrospinal liquor was taken at 1, 24, and 48 hr and several days following exposure. The data show an increase in absorption and a shift of the maximum toward the short-wave side (from 269 up to 265 mμ) one hour after the exposure. A slow increase of optical density with little variation in the position of the maximum was found 24 and 48 hr and 4 and 6 days after exposure. Statistical data verify the absorption maximum at 265 mμ. It is postulated that the absorption maximum is induced not only by nucleinic acids but also by other compound (ascorbic acid). Correlations of the data with those of L. S. Shtern indicate the variations in cerebrospinal liquor spectra, along with brain metabolism variations, may be caused by hemato-encephalitic barrier induced by the radiation. (R.V.J.)

4951 SHORTENING OF LIFESPAN OF MICE AS A FUNCTION OF AGE AT IRRADIATION. Patricia J. Lindop and J. Rotblat (Medical Coll. of St. Bartholomew's Hospital, London). Gerontologia 3, 122-7(1959). (In English)

The life shortening of mice exposed to a single whole-body dose of x rays at an age of four weeks was found to vary linearly with dose; for a dose equal to the LD_{50} the life shortening was 35%. If the irradiation is given at later ages the percentage of life shortening is considerably smaller. The long-term effects of radiation appear thus to show a similar dependence on age at irradiation, as found for acute effects. The possibility of this dependence being due to an oxygen effect is being studied. (auth)

4952 ADULT LONGEVITY AS A SENSITIVE CRITERION OF RADIATION-INDUCED DAMAGE WHEN 24-HOUR HABROBRACON (HYMENOPTERA) EMBRYOS ARE X-RAYED. Howard E. Erdman (General Electric Co., Richland, Wash.). J. Econ. Entomol. 53, 971-2(1960) Oct.

Evidence is presented that adult longevity of Habrobracon is a sensitive criterion of radiation damage when compared with parameters when the wasps are x irradiated as 24-hr-old embryos. (C.H.)

4953 RELATIONSHIP BETWEEN CHROMOSOME PLOIDY AND RADIOSENSITIVITY IN SELECTED TUMOR SUBLINES OF COMMON ORIGIN. László Révész and Ulla Norman (Karolinska Inst. Medical School, Stockholm). J. Natl. Cancer Inst. 25, 1041-63(1960) Nov.

A predominantly hypertetraploid subline, ELT/stock, was derived from a predominantly hyperdiploid Ehrlich ascites tumor, ELD, after homotransplantation of sublethally x-irradiated cells. The ploidy shift was probably the result of immunoselection based on the differential resistance of the polyploid cells against the homograft reaction. Two additional sublines, a pure hypertetraploid, ELT/clone, and a predominantly hyperdiploid population, ELTD, were subsequently selected from ELT/stock. The former was obtained by isolating a hypertetraploid clone (a) and the latter by carrying ELT/stock in serial passage in the absence of immunoselection, in which case hyperdiploid cells regain dominance. The ELTD subline was cytologically indistinguishable from the main ELD line. After irradiation in vitro with different x-ray doses, all sublines were grown intraperitoneally within Millipore diffusion chambers with an average pore size of 0.45 μ, thus isolated from direct contact with host cells. The size of cell population was determined quantitatively at various intervals after inoculation. The growth behavior of all untreated sublines was closely similar. There was a difference in their radiosensitivity, however. After the same dose of x rays, the hypertetraploid sublines started to grow earlier and/or reached a larger population size than the hyperdiploid lines. (auth)

4954 CYTOLOGICAL STUDIES ON RADIATION EFFECTS. I. CHROMOSOME BREAKS IN THE THREE TYPES OF CHROMOSOMES OF YOSHIDA SARCOMA CELLS AND THEIR LOCALIZATION. Toshihide H. Yosida (National Inst. of Genetics, Misima, Japan), Toshihide Tabata, and Hiroyuki Hirumi. J. Radiation Research (Japan) 1, 1-9(1960) June. (In English)

Rats bearing Yoshida sarcoma were irradiated by x rays under the following conditions: deep-therapy installation 160 kvp; filter of 1.0 mm Al; 386 r/min; five different dosages, namely, 10,000, 3000, 2000, 1000, and 500 r were administered in single irradiations to total body of rats. Type B cells with characteristic chromosome breaks or degenerated chromosomes were induced by x irradiation with high doses such as 10,000, 5000, 2000, and 1000 r. They were unsuitable for cytological observations. A-cells with few chromosome breaks were obtained with the highest frequency 10 min after 500-r irradiation. These cells were the most suitable for the observation of chro-

mosome breakages. Ideograms of 34 tumor stem cells containing chromosome breaks were analyzed. The chromosomes of the Yoshida sarcoma comprise three, namely, J-, V-, and rod-shaped types. Among them breaks in the rod-shaped chromosomes occurred at much higher frequency than in the other two types. The localization of breaks was examined statistically. The great majority of chromosome breaks occurred in the middle parts of chromosome arms in all J-, V-, and rod-shaped chromosomes. (auth)

4955 THE GENETIC EFFECTS OF RADIATION ON THE LONGEVITY OF PROGENY IN DROSOPHILA MELANOGASTER. Daigoro Moriwaki and Iwao Tobari (Tokyo Metropolitan Univ.). J. Radiation Research (Japan) 1, 14-22(1960) June. (In English)

In order to estimate the genetic effects of radiation on longevity, the life span of the offspring from irradiated females and from irradiated males were measured. Controls were measured at the same time. The lives of the male offspring of these irradiated parents were significantly shorter than those of the controls. The female offspring of treated parents lived as long as those from the control when they were kept with males; however, they lived significantly shorter periods than the controls when kept alone, without males. The male offspring seemed to be more strongly affected by irradiation than the female offspring. These results suggest that mutations that have an effect on longevity may be induced by x rays, but no linear relation between dose and effect was found. (auth)

4956 LOCAL BONE-MARROW CHANGES SECONDARY TO THERAPEUTIC IRRADIATION. Marguerite P. Sykes, Florence C. H. Chu, and William G. Wilkerson (Sloan-Kettering Inst. for Cancer Research; Memorial and James Ewing Hospitals; Cornell Univ. Medical School, New York). Radiology 75, 919-24(1960) Dec.

Results are reported from a study on the cellularity of the sternal bone marrow in patients who had received therapeutic roentgen doses to the mediastinum. Data are tabulated on the degenerative and regenerative responses at various dose levels. (C.H.)

4957 FREQUENCY OF MUTATIONS INDUCED BY RADIATIONS IN HEXAPLOID SPECIES OF TRITICUM. M. S. Swaminathan and M. V. Prabhakara Rao (Agricultural Research Inst., New Delhi, India). Science 132, 1842(1960) Dec. 16.

The frequency of visible mutations induced by x rays, P^{32}, and S^{35} was calculated in six hexaploid Triticum species. The species with spelted ears and winter habit showed a much lower mutation rate than the free-threshing, spring wheats. (auth)

4958 RADIATION INJURY TO GROWING BONE. PART I. Friedrich Gauwerky (Allgemeine Krankenhauses St. Georg, Hamburg). Strahlentherapie 113, 325-50(1960) Nov. (In German)

A survey of hitherto existing literature concerning the disturbances of bone growth indicated by radiation shows that the knowledge of this radiation action goes back to the first year after the discovery of ionizing rays but that during the time to come, especially in the years from about 1925 to 1945, these facts slipped, in a peculiar way, out of the minds of doctors active in the therapy of radiation, especially in consideration of the consequences of these important observations for an appropriate radiation use. The casuistic reports of the German specialized literature after 1945 have given cause for this study in question, which reports about 45 radiographically presented radiogen bone-growth disturbances in human beings. Some biological basic facts from these clinical observations were, as final deductions, especially emphasized, which in the majority were made on haemangioma patients. Apart from this, some interesting radiation morphological observations were shown. Final deductions in consideration of the radiation therapeutic technique were made in recent years in wide circles. They consist in the first place in the avoidance respectively in the reduction of the doses of the gamma and x-ray treatment as well as in their extensive substitution through the beta rays of artificial radioactive isotopes. For the solution of some quantitative radiobiological problems, further experimental examinations on animals were necessitated. (auth)

4959 RESEARCH ON BIOLOGICAL RADIATION PROTECTION. PART XXXVI. METABOLISM OF 5-HYDROXYTRYPTAMINE IN WHOLE-BODY IRRADIATION OF WHITE MICE AND RATS. Hans-Joachim Melching, Hanna Ernst, and Helmuth Rösler (Universität, Freiburg i. B. and Heiligenberg-Instituts, Ger.). Strahlentherapie 113, 394-401(1960) Nov. (In German)

A study was made of the influence of the body's own metabolism of serotonin produced from whole-body irradiation. The result of the examination of the concentration of elimination of 5-hydroxyindole-acetic-acid, of the content of the endogenous 5-hydroxytryptamine of the brain, spleen, and liver as of the endogen respiration, but especially of the liver, indicate that a direct influence of rays of high energy on the endogenous 5-hydroxytryptamine does not take place. (auth)

4960 THEORETICAL TREATMENT OF MAXIMA AND SATURATION EFFECTS IN DOSE-EFFECT CURVES FOR RADIOINDUCED MUTATIONS. Dieter Noack (Institut für Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Strahlentherapie 113, 475-8(1960) Nov. (In German)

Three possible interpretations are discussed for the appearance of relative maxima in dosage-action curves for radiation-induced mutants by means of a system of simultaneous differential equations. The necessary conditions for the appearance of such maxima, to which the probabilities of mutation and killing must suffice, were deduced and their realization possibilities discussed. (auth)

4961 COMPARATIVE EFFECTS OF RADIATION AND CYTOSTATIC CHEMICALS ON THE BLOOD. L. A. Elson (Royal Cancer Hospital, London). p.522-9 of "The International Society of Hematology; Proceedings of the Seventh Congress, Rome, September 7-13, 1958. Volume I. Reports." New York, Grune & Stratton, 1960.

The effects of a number of nitrogen mustard compounds on the blood picture in rats were compared with the effects of exposure to 200 r whole-body x radiation and 100 rads fast neutrons. Possible reaction mechanisms involved in response to radiomimetic substances are discussed. (C.H.)

4962 INFLUENCE OF IONIZING RADIATION ON THE BLOOD CLOTTING SYSTEM IN VITRO. Z. Latallo, A. Dancewicz, and T. Musialowicz (Inst. of Nuclear Research, Polish Academy of Sciences, Inst. of Hematology, Warsaw). p.1386-91 of "The International Society of Hematology; Proceedings of the Seventh Congress, Rome, September 7-13, 1958. Volume II, 2nd Part. Communications." New York, Grune & Stratton, 1960.

The effects of small doses of ionizing radiation on the blood-clotting components was investigated in vitro. Experiments were performed on human plasma and individual purified components after irradiation with different activities. Results are tabulated. (C.H.)

4963 PROBLEMS OF EVOLUTION OF PHYSIOLOGICAL FUNCTIONS. (Problemy Evolyutsii Fiziologicheskikh Funktsii). 167p. Translation of a Publication of Academy of Sciences, USSR, Moscow–Leningrad, 1958. (OTS-60-51066; PST Cat. No. 184). $1.75(OTS).

The importance of embryophysiology in irradiation of animals and humans is pointed out, and studies of the effects of hypophyseal damage are discussed. Experiments on radiation effects on the development of the spinal cord are reviewed and discussed. (T.R.H.)

Radiation Sickness

4964 (NP-9488) EXTERNAL RADIATION—THE RELATIONSHIP OF ACUTE AND DELAYED EFFECTS AND A SUGGESTED METHOD OF TREATMENT. Crawford F. Sams (California. Univ., Richmond. Inst. of Engineering Research). Aug. 30, 1957. 213p. Project CIVIL.

A review is presented of the literature on radiation injuries and therapy in an attempt to relate the mechanism of extension of acute effects to the delayed phase to a reduction or alleviation through therapy. Radiation causes early aging and shortened life span and the normal aging processes is the topic of the first part of the review. The second part relates radiation injury, acute and delayed, to aging. It is concluded that the correlation sought exists, and a treatment procedure is recommended. (181 references). (T.R.H.)

4965 (JPRS-5761(p.1-22)) ERRORS IN THE DIAGNOSIS OF CHRONIC RADIATION SICKNESS. M. N. Pobedinskiĭ (Pobedinskiy) and L. R. Protas. Translated from Med. Radiol. 5, No. 7, 3-9(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 24029.

4966 (JPRS-5761(p.110-21)) THE COURSE OF RADIATION SICKNESS AND THE CONDITION OF THE SECRETORY FUNCTION OF THE INTESTINE IN DOGS WITH THE USE OF DIETS CONTAINING DIFFERENT FATS. M. F. Nesterin and V. N. Chukaeva (Chukayeva). Translated from Med. Radiol. 5, No. 7, 42-5(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23970.

4967 (JPRS-5761(p.264-8)) THE ACTIVITY OF THE PROPERDIN SYSTEM IN CHRONIC IRRADIATION. I. L. Chertkov, M. P. Bogoyavlenskaya, and T. P. Tsessarskaya. Translated from Med. Radiol. 5, No. 7, 89-90(1960).

Results are reported from a study of the properdin content of the blood during chronic radiation sickness. The investigations were made in patients with malignant tumors complicated by chronic radiation sickness which developed as a result of radiation therapy. (C.H.)

4968 (JPRS-7267) ON THE INTERMEDIATE NUCLEOTIDE METABOLISM IN NORM AND IN RADIATION SICKNESS. (O Promezhutochnom Nucleotidnom Obmene v Norme i pri Luchevoi Bolezni). G. A. Kritskiĭ (Kritskiy). Translated from Izvest. Akad. Nauk S.S.S.R., Ser. Biol., 519-31(1960). 28p. OTS.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 22741.

4969 (JPRS-7271) EFFECT OF INSULIN AND GLUCOSE ON THE GLYCOGEN CONTENT OF THE LIVER IN RADIATION SICKNESS. (Vliyanie Insulina i Glyukozy na Soderzhanie Glikogena v Pecheni pri Luchevoi Bolezni). K. V. Gordeeva (Gordeyeva). Translated from Voprosy Med. Khim. 6, 408-11(1960). 10p. OTS.

Following the irradiation of rats, the glycogen content of the liver decreases considerably. Administration of glucose and glucose with insulin to the irradiated rats inhibits the reduction of glycogen content. (auth)

4970 ATOMIC INJURIES AND THEIR THERAPY. Siegmund Schmidt. Z. ges. inn. Med. u. ihre Grenzgebiete 15, No. 2, 89-?(1960). (In German)

The dangers of radioactive contamination are described. It is indicated that uptake of radioactive materials throughout the plant-animal-man cycle is especially important. Any quantity of radiation penetrating an organism can produce genetic damage. Radiation injuries of the cell lead to inhibition of enzyme systems, ionization of cell water, and destruction of humoral control of the pituitary and adrenals. The direct effects of radiation damage are vomiting, leukocyte count drop, thrombopenia, erythema, alopecia and a late effect on the whole organism from toxic products. It was established that the treatment up to now has been shock therapy with hydrocortisone, complete bed rest, protein-rich diet, blood transfusions, skin transplants, terramycin salve and other antibiotics. Attempts at detoxification (complexing agents and cysteine-containing substances) are regarded as essential. Additional suggestions are algin hydrolysates, leukocyte transfusions, and direct bone-marrow transfers since these preparations exert a biological detoxification by their catalase content. An improvement is produced by cerium preparations. Modenium is indicated for its good effects as an enzyme preparation. The revitalizing properties of Bogomoletz serums, tissula, dry cells, and polyhydrolysates as catalysts for restoration of damaged organs are useful. (T.R.H.)

CHEMISTRY

General and Miscellaneous

4971 (NYO-9112) MOLECULAR ASSOCIATION AND ELECTRONIC STRUCTURES OF NICKEL(II) CHELATES. I. COMPLEXES OF PENTANE-2, 4-DIONE AND SOME 1,5-DI-SUBSTITUTED DERIVATIVES. F. A. Cotton and J. P. Fackler, Jr. (Massachusetts Inst. of Tech., Cambridge). Nov. 30, 1960. 41p. Contract AT(30-1)-1965. OTS.

A new phenomenon which can, under certain circumstances, account for anomalous magnetic and spectral behavior of planar nickel(II) complexes has been discovered. This is molecular association of the solute molecules in solvents of low coordinating power. It is shown that the magnetic moment and spectrum of bis(2,6-dimethyl-3,5-heptanediono)nickel(II), $Ni(DIBM)_2$, dissolved in toluene, are dependent upon both temperature and concentration. Spectral and magnetic data over a temperature range of 0 to 50°C and a concentration range of 0.24 to 0.010 M are reported and association constants and thermodynamic parameters of the association process evaluated therefrom. It is also shown that the more highly hindered bis(2,2,6,6-tetramethyl-3,5-heptanediono)nickel(II), $Ni(DPM)_2$, remains diamagnetic under all conditions. Preliminary results show that bis(2,4-pentanediono)nickel(II) is associated in noncoordinating solvents at ordinary temperatures, with significant concentrations of red monomer occurring only at temperatures near 200°C and above. Possible structures for the polymeric species are considered. (auth)

4972 (NYO-9398) FINAL REPORT [FOR SEPTEMBER 1, 1959 TO AUGUST 31, 1960]. James B. Hyne. Includes Appendices: 1. ION PAIRS IN SULFONIUM SALT

SOLVOLYSIS. J. B. Hyne and J. W. Abrell. 2. PRELIMINARY REPORT ON KINETICS OF SOLVOLYSIS OF SULFONIUM SALTS IN DIOXANE–WATER MIXTURES. J. E. Gurst and J[ames] B. Hyne. Appendix 3. PRELIMINARY REPORT ON POLYCARBOXYLIC ACID-INORGANIC ION BINDING STUDIES. Ada L. Jacobson and J[ames] B. Hyne (Dartmouth Coll., Hanover, N. H.). 16p. Contract AT(30-1)-2443. OTS.

The work on the development and refinement of the flow-counting technique for the study of solution kinetics was completed. A detailed investigation of the mechanism of solvolysis of dimethyl-t-butylsulfonium iodide in ethanol–water mixtures was completed. Studies are continuing on the problem of the kinetics and mechanism of decarboxylation reactions. In Appendix 1, an investigation was made of ion pairing in the rate determining factor in the solvolysis of sulfonuim salts in media of dielectric constant 40 and below. Appendix II is a preliminary report on the kinetics of solvolysis of sulfonuim salts in dioxane–water mixtures. In Appendix III, a preliminary study is presented on polycarboxylic acid-inorganic ion binding. (W.L.H.)

4973 (SRB-60-13) HIGH TEMPERATURE MATERIALS FOR ENCAPSULATION. AN ANNOTATED BIBLIOGRAPHY. Maureen M. Pearcy, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Nov. 1960. 37p. OTS.

This bibliography includes 98 references on high-temperature materials for encapsulation. The sources include those to be found at the Lockheed Missiles and Space Division Information center and pertinent indexes and abstract journals. (J.R.D.)

4974 (TID-6374) RADIOISOTOPE EXPERIMENTS FOR THE CHEMISTRY CURRICULUM. Norman Radin, ed. (Nuclear-Chicago Corp., Chicago). Aug. 15, 1960. 163p. Contract AT(11-1)-738. OTS.

The curriculum includes experiments in qualitative analysis, quantitative analysis, organic chemistry, physical chemistry, instrumental analysis, and biochemistry. (W.L.H.)

4975 (TID-6375) RADIOISOTOPE EXPERIMENTS FOR THE CHEMISTRY CURRICULUM. INSTRUCTOR NOTES. (Nuclear-Chicago Corp., Chicago). Aug. 15, 1960. 62p. Contract AT(11-1)-738. OTS.

4976 (TID-6876) RÉSUMÉ OF RESEARCH DONE DURING THE PAST YEAR. [Chicago. Univ.]. 1960. 5p. Contract [AT(11-1)-378]. OTS.

Progress is reported on the following investigations: solvation numbers of cations in methanol; electron transfer reactions; kinetics of reactions of metals in liquid NH_3; complex ion reactions; and studies with O^{17}. (W.L.H.)

4977 (TID-6984) SCINTILLATING ION EXCHANGE RESINS. Quarterly Report. A. H. Heimbuch (Tracerlab, Inc., Richmond, Calif.). Aug. 8, 1960. 16p. Contract AT(30-1)-2525. OTS.

Plastic beads containing both scintillating and ion exchange properties were prepared. Polyvinyl toluene scintillating beads were sulfonated on the surface by two methods. The first method employed 10% chlorosulfonic acid in sulfuric as the sulfonation medium. Sulfur trioxide gas was used in the second method. The pulse height was reduced 25% by the first method and 30% by the second. However, total counting efficiency was affected only slightly. The ion exchange capacity was measured by radio tracer techniques as the number of sulfonic groups was too small to be analyzed quantitatively by conventional methods. The exchange capacity was calculated to be 1.5×10^{-4} milliequivalent per gram of beads in the first preparation and 6.3×10^{-4} in the second. Even though this exchange capacity is extremely small compared to commercial resins, experiments indicate that this is sufficient to measure carrier-free isotopes in solutions of low specific activity. This is true where conditions of ion exchange are selective enough to prevent interference by other elements, i.e., calcium ion does not interfere with the adsorption of strontium ion in EDTA solutions at pH 5:5. (auth)

4978 (AAEC/Trans-1) THE DETERMINATION OF THE FORMATION CONSTANT OF INDIUMACETYLACETONATE BY AN EXTRACTION METHOD. N. P. Rudenko and I. Stary. Translated by H. J. de Bruin from Trudy Komissii Anal. Khim. Akad. Nauk S.S.S.R., Inst. Geokhim. Anal. Khim. 9, 28-43(1958). 19p.

The solubility of acetylacetone was determined in an acetate buffer solution of ionic strength C.1 in relation to pH and temperature. The distribution coefficients of acetylacetone were determined between chloroform, carbon tetrachloride, benzene, and an acetate buffer solution in relation to acetylacetone concentration and pH. Relations were established between the rate at which indium acetylacetonate reaches partition equilibrium and the pH, initial acetylacetone concentration in the organic phase, and the different organic solvents. The extent of the extraction of indium acetylacetonate was determined for three organic solvents at two acetylacetone concentrations in relation to pH. The independence of the degree of extraction from indium concentration was established in the region between 10^{-4} to 10^{-4} M. The indium acetylacetone compound was obtained by extraction from organic solvents. The stability constants were calculated by two different methods for the uncharged complex and intermediate complexes; the constants for the various steps of the dissociation of indium acetylacetonate also were calculated. (auth)

4979 (AEC-tr-4375) PAPER CHROMATOGRAPHY OF INDOLE DERIVATIVES. Ž. Procházka, V. Šanda, and K. Macek. Translated by Lydia Venters (Argonne National Lab.) from Collection Czechoslov. Chem. Commun. 24, 2928-38(1959). 14p. JCL.

The R_F values of more than 70 indole derivatives were measured in some solvent systems, and their color reactions were identified by using two reagents. On the basis of the data obtained, numerous group constants for some solvent systems were calculated, and the relation between the R_F value and the structure of the indole derivatives was discussed. (auth)

4980 (UCRL-Trans-602) VALENCE BONDS IN SOME BINARY COMPOUNDS. (Les Liaisons de Valence dans Quelques Composes Binaires). René Benoit. Translated by D. A. Nimidoff from J. chim. phys. 52, 201-6(1955). 16p. JCL.

From magnetic properties and theoretical considerations, some conclusions are drawn concerning the valence bonds in sulfides and disulfides. To the bisulfides a covalent bond is attributed with a feeble metallic character because of bond mobility. VS, CrS, MnS, and FeS clearly have ionic valence bonds. CoS and NiS are covalent and fairly unstable. (T.R.H.)

4981 (UCRL-Trans-624) PHOTOCONDUCTIVITY KINETICS OF PHTHALOCYANINS. E. K. Putseiko. Translated from Doklady Akad. Nauk S.S.S.R. 132, 1299-1302 (1960). 9p. JCL or LC.

The processes of photoconductivity relaxation phthalocyanines in the very first stages were studied. The sub-

jects of study were high-vacuum sublimated layers of phthalocyanines containing copper and magnesium, as well as metal-free phthalocyanine. The layers of pigments under study, from 0.1 to several microns in thickness, were deposited by sublimation in a vacuum on quartz or mica base surfaces that had platinum or gold electrodes separated by an interval of 1 mm. (W.L.H.)

4982 THE FORMATION OF HYDROGEN PEROXIDE IN ALCOHOLS. ITS EFFECT ON THE EXTRACTION OF CHELATES OF BENZOHYDROXAMIC ACID. Clifton E. Meloan and Warren W. Brandt (Purdue Univ., Lafayette, Ind.). Anal. Chem. 33, 102-4(1961) Jan.

A colorimetric procedure is devised for determining trace amounts of hydrogen peroxide in alcohols. Hydrogen peroxide destroys the benzohydroxamic acid chelates of uranium, vanadium, and iron when dissolved in alcohol. Steps to eliminate hydrogen peroxide formations are outlined. (auth)

4983 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF HYDROGEN PEROXIDE. D. E. Meloan, M. Mauck, and C. Huffman (Kansas State Univ., Manhattan). Anal. Chem. 33, 104-6(1961) Jan.

A spectrophotometric method for determining hydrogen peroxide is based on the destruction of benzohydroxamic acid chelates of uranium and vanadium. The decrease in color intensity of the metal chelate is directly proportional to the amount of hydrogen peroxide present. Hydroperoxides and dialkyl peroxides do not interfere. (auth)

4984 DETERMINATION OF THE COMPOSITION AND THE STABILITY CONSTANTS OF METALLIC COMPLEXES BY EXTRACTION METHODS. J. Starý (Charles Univ., Prague). Collection Czechoslov. Chem. Communs. 25, 2630-41(1960) Oct. (In German)

A generally valid relation for the establishment of the composition and the stability constants of a nonextractable complex, $MB_s(OH)_t$, was derived. The values determined in this manner for the stability constants of some U(VI) complexes are more accurate than the values established by other methods. (tr-auth)

4985 NEW TETRAHEDRAL COMPLEXES OF NICKEL(II). F. Albert Cotton and David M. L. Goodgame (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc. 82, 5771-4(1960) Nov. 20.

The Ni(II) complexes $[(C_6H_5)_3PO]_2NiX_2$ where X = Cl, Br, and I were prepared. Their physical properties, especially their electronic spectra and high magnetic moments, leave little doubt that the nickel ion is in each case surrounded by two oxygen atoms and two halogen ions in an essentially tetrahedral array. (auth)

4986 TETRAHEDRAL COMPLEXES OF NICKEL(II) CONTAINING TRIPHENYLARSINE OXIDE. David M. L. Goodgame and F. Albert Cotton (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc. 82, 5774-6(1960) Nov. 20.

The preparation and properties of the compounds $[(C_6H_5)_3AsO]_2NiCl_2$, and $[(C_6H_5)_3AsO]_2NiBr_2$ are reported. Magnetile and spectral data are adduced and interpreted to show that these compounds contain pseudotetrahedrally coordinated nickel(II) ions just as do the $[(C_6H_5)_3PO]_2NiX_2$ compounds. Unsuccessful attempts to prepare analogous compounds with triphenylstibine oxide are described briefly. (auth)

4987 CONTRIBUTION TO THE STUDY OF SOME COMPLEX COBALT CARBONATES BY INFRARED SPECTROSCOPIC METHODS. Jean Lascombe (Commissariat à l'Energie Atomique, Saclay, France). J. chim. phys. 56: 79-84(1959). (In French). (CEA-1143)

The infrared spectra of cobalticarbonatopentammine, cobalticarbonatotetrammine and cobaltitricarbonate ions dispersed in potassium bromide are presented and analyzed. The purity of the samples, the action of potassium bromide, and also the vibration frequencies characteristic of the complex CO_2 group are discussed. (auth)

4988 THE FORMATION OF CHLORO-URANYL COMPLEXES IN ISOPROPYL ALCOHOL. Stefan Minc and Maria Siekierska (Univ. of Warsaw and Inst. of Physical Chemistry, Polish Academy of Sciences, Warsaw). Nukleonika 5, 109-14(1960). (In Polish)

Bjerrum's method of corresponding solutions was applied to the system $UO_2Cl_2 + NH_3BuCl$ + isopropyl alcohol; cobalt (II) was the indicator of free chloride ion concentration. The formation curve of chloro-complexes of the indicator cation was determined using the isobestic points observed in absorption curves series corresponding to constant Co (II) concentration and increasing concentrations of chloride ions. The formation curve determined for $UO^{2+} - Cl^-$ systems in isopropyl alcohol solutions seems to indicate the tetrachlorouranyl complex being the limiting one. (auth)

4989 COMPLEXING OF YTTRIUM. M. G. Panova and V. I. Levin. Radiokhimiya 2, 568-73(1960). (In Russian)

Coefficients of 8-oxiquinoline distribution between chloroform and aqueous 3 M $NaClO_4$ were measured. It is shown that with pH <5.5 and >9.0 the logarithm of oxine distribution as a function of pH can be expressed by straight lines at tangents of +1 and −1, respectively. Dissociation constants of oxine at $\mu = 3.0$ calculated with the oxine distribution coefficient as a function of pH are $pK_1 = 5.57 \pm 0.08$ and $pK_2 = 9.03 \pm 0.08$. (R.V.J.)

Analytical Procedures

4990 (AAEC/E-47) THE ESTIMATION OF TRACES OF OXYGEN AND NITROGEN IN HELIUM BY MASS SPECTROMETRY. R. H. Piper and R. N. Whittem (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Jan. 1960. 9p.

Mass spectrometer analysis of helium for traces of oxygen and nitrogen may be made using figures for the relative ionization efficiency of the pure gases. (auth)

4991 (AERE-AM-56) THE SPECTROGRAPHIC DETERMINATION OF BERYLLIUM IN ATMOSPHERIC DUSTS. J. C. Cotterill (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Sept. 1960. 15p. BIS.

The dust to be examined is collected by drawing a known volume of air through a 7-cm Fourstones filter paper. The paper is then impregnated with a solution containing 7 mg of iron and 1 mg of nickel. The paper is ashed and ground with 40 mg of ammonium sulfate. Pellets of this mixture are excited by the iron-flux method (AERE−AM 46) and the resulting spectra are evaluated by microphotometry, using nickel as internal standard. (auth)

4992 (BM-RI-5644) DETERMINING TRACE IMPURITIES IN GRADE-A HELIUM. C. G. Kirkland, L. W. Brandt, and W. M. Deaton (Bureau of Mines, Washington, D. C.). Feb. 25, 1960. 15p.

An apparatus for determining trace impurities in helium (99.995% pure) is described. The apparatus concentrates the impurities in helium by freezing them out in a coil-and-

trap assembly cooled by liquid helium. Samples of the concentrated impurities are analyzed by a mass spectrometer. (C.J.G.)

4993 (DEG-Report-219) THE DETERMINATION OF ALUMINIUM IN PURE URANIUM AND IN ALUMINIUM–URANIUM ALLOYS (OXINE SPECTROPHOTOMETRIC PROCEDURE). C. O. Granger (United Kingdom Atomic Energy Authority. Development and Engineering Group, Culcheth, Lancs, England). Aug. 24, 1960. 18p. BIS.

The development of a rapid spectrophotometric method for the determination of aluminum in pure uranium or in uranium–aluminum alloys is described. Aluminum is extracted into chloroform as its complex with 8-hydroxyquinoline, and the absorbancy of the extract is measured at 390 mμ. Before the extraction, iron is reduced with thioglycolic acid and interferences are eliminated by adding E.D.T.A. and potassium cyanide; uranium is held in solution by a buffer mixture of sodium carbonate and bicarbonate. Applied to uranium and uranium–aluminum alloys, precision (3 σ criterion) is 0.9 μg over the range 0 to 50 μg aluminum in the presence of 0 to 5 g uranium. Eight determinations can be carried out in half a day, excluding the preparation of reagents. Alloys containing zirconium, titanium, and vanadium must have these metals removed before the aluminum content is determined. The development of a method for their solvent extraction as complexes with N-benzoyl-N-phenyl hydroxylamine is described. (auth)

4994 (HW-66220) DETERMINATION OF THORIUM IN URANIUM ORES. R. Ko and M. R. Weiler (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 26, 1960. 14p. Contract AT(45-1)-1350. OTS.

A method was developed for the determination of 1 ppm of thorium in 1 g of uranium ore. Thorium was separated by LaF_3 precipitation and TTA extraction. The final solution was analyzed spectrographically after adding zirconium internal standard. The precision of the method expressed as a coefficient of variation was ±12% at 1 ppm. Th^{234} tracer recovery was 84%. (auth)

4995 (NP-9641) MICROCHROMATOGRAPHIC ESTIMATION OF COPPER, NICKEL, CADMIUM, AND ZINC. (Mikrochromatograficzna Metoda Rozdzielania Cu, Ni, Cd, i Zn). Report No. 138/VIII. J. Minczewski and A. Foldziñska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1960. 8p.

A chromatographic method was devised for separating and determining Cu, Cd, Zn, and Ni (in quantities of 0.025 to 0.25 μg) in the presence of Pb, Bi, Fe, Ag, Hg, Mn, Sn, and partly Co. Dithizone was used as a precipitant. The method is rapid and requires a small volume (0.025 ml) of relatively highly diluted solutions (1 to 10 μg/ml). By using standards the method may be applied to exploratory, semiquantitative determination of the elements in even fairly complicated mixtures. (auth)

4996 (NP-9642) DETERMINATION OF RADIOACTIVE STRONTIUM IN URINE. (Oznaczanie Promieniotwórczego Strontu w Moczu). Report No. 139/X. Z. Jaworowski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1960. 8p.

A radiometric procedure for determining strontium in urine is described. The detection limit is 10 μμc of Sr^{89}/l sample, and a mean recovery of 64.3%. (auth)

4997 (PG-Report-142) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF URANIUM IN GRASS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). Aug. 9, 1960. 10p. BIS.

A sample of the grass is subjected to wet oxidation using a sulfuric/nitric acid mixture. Any silica in the residue is removed by treatment with hydrofluoric acid. The silica-free residue is dissolved in nitric acid and the uranium is coprecipitated with added iron using ammonia solution. The precipitate, redissolved in nitric acid, is twice extracted with diethyl ether, which is distilled off. The treated residue is dissolved in dilute sulfuric acid, and the solution is poured into alkaline pyrophosphate reagent. After the addition of hydrogen peroxide, the uranium is determined absorptiometrically. (auth)

4998 (PG-Report-144) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF FLUORIDE IN GRASS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1960. 8p. BIS.

The grass sample is dried in the presence of magnesium acetate. The ash is pyrohydrolyzed at 1000°C. Fluoride is determined in an aliquot of the pyrohydrolysis condensate absorptiometrically using solochrome cyanine. (auth)

4999 (TID-11209) THE DETERMINATION OF MICRO QUANTITIES OF HAFNIUM AND ZIRCONIUM IN URANIUM AND THORIUM MATERIALS. M. G. Atwell and H. A. Heller (National Lead Co. of Ohio, Cincinnati). [1957]. 9p. OTS.

The development of a method for determining microquantities of hafnium and zirconium in uranium and thorium materials is described. The procedure will permit the analysis of purified uranium materials, uranium concentrates, or thorium with satisfactory precision. Data obtained in the sample tests are included. (J.R.D.)

5000 (USNRDL-TR-440) THE RADIOMETRIC DETERMINATION OF ORGANIC PRECIPITANTS. H. V. Weiss and M. G. Lai (Naval Radiological Defense Lab., San Francisco). July 7, 1960. 10p.

The radiometric determination of two organic precipitants, potassium rhodizonate and α-nitroso-β-naphthol, is described. The method involves the quantitative precipitation of the organic reagent with a radioactive element and isotopic carrier and the subsequent determination of activity in the precipitated material. (auth)

5001 (AAEC/Trans-2) INVESTIGATION OF THE REACTION OF BERYLLIUM WITH ALUMINON. L. S. Serdyuk and G. P. Federova. Translated by H. J. de Bruin from Ukrain. Khim. Zhur. 3, 384(1958). 7p.

The complex formation reaction between beryllium and aluminon was investigated for different values of pH. It was established that at pH between 4 and 5 a complex is formed containing the constituents in the ratio 1:1. At a pH between 7 and 8 a complex is formed having a beryllium-aluminon ratio of 3:1. At pH 6 both complexes are formed. It is shown that the complexes can be distinguished optically and in other aspects. The colorimetric determination of beryllium with aluminon is made at pH 5. At this pH value the results obtained for the determination of beryllium are satisfactory and are of sufficient reproducibility. (auth)

5002 (AEC-tr-4318) RAPID METHODS IN THE ANALYSIS OF METALS AND MINERAL RAW MATERIALS. VII. POLAROGRAPHIC DETERMINATION OF CERIUM IN ALLOYS AND MINERAL RAW MATERIALS. J. Doležal and J. Novak. Translated from Collection Czechoslov. Chem. Communs. 24, 2291-8(1959). 18p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 22013.

5003 (AEC-tr-4370) THE SEPARATION OF CERIUM FROM LANTHANUM AND DIDYMIUM AND ITS QUANTI-

TATIVE DETERMINATION IN MIXTURES OF THE LATTER. P. Mengel. Translated by Karl S. Vorres (State Univ. of Iowa) from Z. anorg. Chem. 19, 67-77(1899). 16p. JCL.

Procedures for separation of cerium from lanthanum and didymium (Nd and Pr) are reviewed. Quantitative experiments also are discussed. (J.R.D.)

5004 (CEA-tr-R-955) APPLICATION DE LA POLAROGRAPHIE OSCILLOGRAPHIQUE À L'ANALYSE QUANTITATIVE. (Application of Oscillographic Polarography in Quantitative Analysis). R. Kalvoda. Translated into French from Zavodskaya Lab. 24, 1319-26(1958). 21p.

The oscillographic polarography technique is described, and its applications in quantitative analysis are pointed out. The technique involves measurement of the polarization with a very stable current or, for very low quantities (10^{-5} to 10^{-9} moles), previous electrolysis of the element studied on a mercury cathode followed by polarographic analysis of the amalgam obtained. The conditions for electrolysis are discussed generally, and the specific conditions are given for the determination of Cu, Tl, Cd, Zn, Bi, Pb, In, Sn, Na, K, NH_4^+, Ba, Sr, and for determining the purity of reagents. Determinations in the presence of an excess of the depolarizer, which does not form an amalgam, are also discussed. (T.R.H.)

5005 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN ALUMINUM ALLOYS. G. Matelli and V. Vicentini (Istituto Sperimentale dei Metalli Leggeri, Novara, Italy). Alluminio 29, 453-7(1960). (In Italian)

The possibility of applying the Mills-Hermon photometric method for the determination of zirconium in Hiduminium R.R. 350 alloy to the analysis of various aluminum alloys was examined. The substantial differences between the behavior of aluminum or its alloys and Hiduminium R.R. 250 alloy were investigated with respect to the development of the chromogenic reaction and the fundamental color. (tr-auth)

5006 COULOMETRIC GENERATION AND BACK-TITRATION OF INTERMEDIATE REAGENTS AT CONTROLLED POTENTIAL. APPLICATION TO THE DETERMINATION OF PLUTONIUM. W. D. Shults (Oak Ridge National Lab., Tenn.). Anal. Chem. 33, 15-18(1961) Jan.

Coulometric reagents for secondary processes may be electrolytically generated and back-titrated at controlled electrode potential rather than controlled electrolysis current. Some of the advantages of this technique and the factors to be considered are mentioned, and the technique is illustrated by application to the indirect determination of plutonium(VI) with iron(II). (auth)

5007 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN URINE. Herbert V. Weiss and William H. Shipman (U. S. Naval Radiological Defense Lab., San Francisco). Anal. Chem. 33, 37-9(1961) Jan.

An improved method was developed for the determination of plutonium in urine. Plutonium was cocrystallized with potassium rhodizonate from urine. It was then purified from interfering substances by coprecipitation with lanthanum salts and by ion exchange. Finally, the radioelement was electrodeposited onto a tantalum disk and α counted. The average recovery was 91.3 ± 5.0% and the analysis time 5 to 6 hours. (auth)

5008 RADIOCHEMICAL DETERMINATION OF RADIUM IN URINE. Herbert V. Weiss and Ming G. Lai (U. S. Naval Radiological Defense Lab., San Francisco). Anal. Chem. 33, 39-41(1961) Jan.

Trace amounts of radium-223 in urine are determined by radiochemical technique. The radium is cocrystallized with potassium rhodizonate and purified by ion exchange. This sensitive procedure has the advantages of carrier-free isolation, simple operation, and economy of time. (auth)

5009 X-RAY RAYLEIGH SCATTERING METHOD FOR DETERMINATION OF URANIUM IN SOLUTION. J. C. McCue, L. L. Bird, C. A. Ziegler, and J. J. O'Connor (Tracerlab Inc., Waltham, Mass.). Anal. Chem. 33, 41-3 (1961) Jan.

The Rayleigh scattering measurement technique to determine high Z atoms in low Z media is used for the analysis of uranium in solution. The detection of uranium is enhanced by its fluorescence in the energy band yielding the Rayleigh signal increase. (auth)

5010 RAPID METHOD FOR SEPARATION AND ANALYSIS OF RADIOACTIVE FISSION GASES. R. C. Koch and G. L. Grandy (Nuclear Science and Engineering Corp., Pittsburgh). Anal. Chem. 33, 43-8(1961) Jan.

An analytical method and apparatus were developed for rapid determination of the concentrations of radioactive fission gases in helium streams. The method involves sampling of the helium stream, quantitative separation of the xenon and krypton from the helium, from other fission products, and from each other, and γ spectrometry assays for isotopes in the separated fractions. Charcoal beds are used for both the sampling and the gas chromatographic separation steps. Analytical procedures were developed for quantitative analysis of Kr^{85m}, Kr^{87}, Xe^{132}, Xe^{135}, and Xe^{138} in helium streams containing mixed fission gases. Precisions not exceeding 7% were achieved for these nuclides. In addition, a semiquantitative analytical procedure for 3.2-minute Kr^{89} was developed. This method has applications for fission gas analyses in both reactor and fuel processing plants. (auth)

5011 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM AND MOLYBDENUM WITH 8-QUINOLINOL IN URANIUM-BASE ALLOYS. Kenji Motojima and Hiroshi Hashitani (Atomic Energy Research Inst., Ibaraki-ken, Japan). Anal. Chem. 33, 48-52(1961) Jan.

Niobium and molybdenum are accurately determined by spectrophotometric procedure using 8-quinolinol. After the sample-reagent reaction the quinolinate is extracted with chloroform and measured spectrophotometrically. Fluoride ion is used as a masking agent for uranium. (auth)

5012 QUANTITATIVE RADIOCHEMICAL ANALYSIS BY ION EXCHANGE. CALCIUM, STRONTIUM, AND BARIUM. Leon Wish (U. S. Naval Radiological Defense Lab., San Francisco). Anal. Chem. 33, 53-5(1961) Jan.

An ion exchange procedure was developed for the separation of calcium, strontium, and barium from the rare earths and from each other. By lowering the cross linkage of the column resin to 8% and changing the concentration and pH, it was possible to accomplish the analytical separation at room temperature. Column runs with Ce^{144}, Ca^{45}, Sr^{85}, and Ba^{133} tracers showed that the recoveries were quantitative. No significant cross contamination could be detected by γ-ray spectrometer measurements. The determination of barium and strontium was then included in the sequential radiochemical analytical scheme for mixed fission product and actinide elements. (auth)

5013 DETERMINATION OF URANIUM IN ZIRCONIUM ORES. A MODIFICATION OF THE STANNOUS CHLORIDE METHOD. K. Bril and S. Holzer (Research Lab., Orquima S/A, Sao Paulo, Brazil). Anal. Chem. 33, 55-8(1961) Jan.

A modified stannous chloride reduction method is used

for determining uranium in zirconium ores. Uranium(VI) is reduced with sodium fluoride instead of orthophosphoric acid and determined by titration with ceric sulfate against a ferrous o-phenanthroline indicator. Interference is eliminated by tributylphosphate extraction. (auth)

5014 EXTRACTION OF ZIRCONIUM WITH Di-n-BUTYL PHOSPHATE AND DIRECT DETERMINATION IN THE ORGANIC PHASE WITH 1-(2-PYRIDYLAZO)-2-NAPHTHOL. APPLICATION TO FLUORIDE SOLUTIONS. R. F. Rolf (Dow Chemical Co., Midland, Mich.). Anal. Chem. 33, 125-8(1961) Jan.

The separation and determination of zirconium in aluminum-magnesium alloys are accomplished by a sensitive spectrophotometric procedure. The sample is dissolved in fluoboric acid–hydrochloric acid and zirconium extracted with di-n-butyl phosphate in chloroform. The reaction with 1-(2-pyridylazo)-2-naphthol yields a red color with maximum absorbance at 555 mμ. Fluoride is complexed with ammonium nitrate and does not interfere. (auth)

5015 SIMPLIFIED DETERMINATION OF STRONTIUM-90. PREFERENTIAL EXTRACTION OF YTTRIUM WITH TRIBUTYL PHOSPHATE. R. J. Velten and A. S. Goldin (Robert A. Taft Sanitary Engineering Center, Cincinnati). Anal. Chem. 33, 128-31(1961) Jan.

A simplified approximate method for the determination of Sr^{90}, particularly applicable for screening purposes, is based on the preferential extraction of Y^{90} by tributyl phosphate from strong nitric acid solution. The radioactive interferences—namely, the rare earths and zirconium-niobium—and the effects of calcium and of phosphates are discussed. In many cases, where alkaline earth activities are relatively enriched, useful preliminary results may be obtained in one day. These results may be readily improved in a few additional days by correcting for impurities on the basis of decay measurements. (auth)

5016 THE DETERMINATION OF SURFACE-ACTIVE CHELATING AGENTS. Sarah Mook, Ernest Schonfeld, and Dipen Ghosh (Radiation Applications, Inc., Long Island City, N. Y.). Anal. Chem. 33, 150-1(1961) Jan.

The Darbey colorimetric method for EDTA determination was adapted for determining concentrations of dodecyl benzyl(diethylenetriamine)-tetraacetic acid. The calibration curve follows Beer's Law in the range 0 to 250 mg/l, and reproducibility within a run is good, although the curve shifts ≤10% from day to day, requiring a curve to be made concurrently with the sample solutions. (D.L.C.)

5017 CHEMICO-ANALYTICAL EQUIPMENT FOR RADIOACTIVE PRODUCTS. M. Douis, A. Guillon, H. Laurent, and R. Sauvagnac. Compt. rend. congr. intern. chimie. ind., 31e, Liège, 1958. Ind. chim. belge, Suppl. 1959. 6p. (In French). (CEA-1125)

A shielded enclosure, hermetic, for analytical examination and handling of radioactive products is described. Remote handling for the following is provided: pipette absorption, weighing, centrifuging, dessication, volumetrics, pH measurement, potentiometrics, colorimetrics, and polarographics. The enclosure was also designed for the rapid installation of other equipment. Powerfully ventilated and screened to 400 mc levels by 5 cm of lead, the enclosure is fully safe to the stated level. (auth)

5018 MACRO AND MICRO DETERMINATION OF COBALT TRACES. VIII. DIRECT DETERMINATION OF COBALT IN INCONEL, BY ACTIVATION WITH THERMAL NEUTRONS; LIMITS OF THE DETERMINATION AND INTERFERENCES. W. Haerdi, J. Vogel, and D. Monnier (Université, Geneva). Helv. Chim. Acta 43, 1585-95(1960). (In French)

The assay of traces of Co^{60} by the method of recording spectra, using a one canal gamma spectrometer, was completely investigated. The interferences due to Fe^{59} and Co^{60} were studied in detail. A method is described for the direct assay (without dissolution or separation) of cobalt in Inconel by activation by thermal neutrons. This determination can still be effected readily on only 0.1 mg of this alloy. The method is rapid, simple, and sensitive. (auth)

5019 PRACTICAL NEUTRON ACTIVATION ANALYSIS FOR THE ELECTRONIC SCIENTIST. J. P. Cali and J. R. Weiner (Air Research and Development Command, Bedford, Mass.). J. Electrochem. Soc. 107, 1015-19(1960) Dec.

Neutron activation analysis is an extremely sensitive analytical method for determining trace impurities in semiconductor materials. Theoretical aspects are discussed, and procedures are outlined. Parameters which determine sensitivity are considered as well as the techniques whereby they may be varied to increase sensitivity. Tables are included which list elements that can be determined by neutron activation analysis, their half lives, and minimum detectable amounts. Also tabulated are elemental matrix materials of electronic interest together with naturally occurring associated impurities which are determined by neutron activation analysis and other methods. These matrices are also ranked according to extent of flux perturbations, degree of self-activation, and ease of chemical separation. (auth)

5020 METHOD FOR THE SEPARATION OF TITANIUM, ZIRCONIUM, IRON, AND ALUMINUM FROM ONE ANOTHER AND FOR THEIR SUBSEQUENT DETERMINATION. Thomas J. Murphy, W. Stanley Clabaugh, and Raleigh Gilchrist. J. Research Natl. Bureau Standards 64A, 535-42(1960) Nov.-Dec.

A method is described for the separation of titanium, zirconium, iron, and aluminum from one another and for their subsequent determination. Iron was first precipitated with 1-nitroso-2-naphthol after complexing the titanium and zirconium with citrate to prevent their precipitation. Titanium and zirconium were then collectively precipitated with cupferron and subsequently separated from each other by precipitating the titanium with 8-hydroxyquinoline after complexing the zirconium with ethylenediaminetetraacetic acid. Aluminum and zirconium were recovered from their respective solutions by precipitation with cupferron. The accuracy of the method was proved by analyzing synthetic solutions containing known amounts of the four elements. (auth)

5021 DETERMINATION OF THORIUM WITH o-CRESOTIC ACID & 4-AMINO SALICYLIC ACID. V. V. Subbanna and A. K. Bhattacharya (Univ. of Saugor, India). J. Sci. Ind. Research (India) 19B, 409(1960) Oct. (In English)

o-Cresotic acid and 4-amino salicylic acid were found to be satisfactory reagents for the quantitative analysis of thorium, the optimum pH range for the two reagents being 1.5 to 5.5 and 1.5 to 3.5, respectively. Double precipitation is necessary if cations like Fe^{3+}, Co^{2+}, Ni^{2+}, Ce^{4+}, Cu^{2+}, and UO_2^{2+} are present. Thorium cannot be separated from zirconium by these reagents as the latter is also precipitated quantitatively in the same pH range. (auth)

5022 INVESTIGATIONS ON SOME METHODS OF SEPARATION AND DETERMINATION OF URANIUM. Jerzy Minczewski, Jerzy Malinowski, Teresa Jankowska

(Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika 5, 115-22(1960). (In Polish)

Using statistical methods, the following methods of separation and determination of uranium were investigated and evaluated: A. Methods of separation: A.1. Ether extraction. 2. Extraction with a solution of sodium diethyldithiocarbamate. 3. Cellulose column separation. 4. Carbonate method of separation. B. Methods of simultaneous separation and determination: B.1. Ethyl acetate-ammonium thiocyanate method. 2. Tributylphosphate-dibenzoylmethane method. C. Methods of determination: C.1. Spectrophotometric peroxide method. 2. Titration with vanadate. 3. Titration with cerate. 4. Potentiometric titration with chromous sulfate. 5. Spectrophotometric dibenzoylmethane method. The results of the investigation are tabulated. (auth)

5023 ANALYSIS OF MICROADMIXTURES IN SELENIUM AND TELLURIUM BY NEUTRON ACTIVATION. V. I. Shamaev. Radiokhimiya 2, 624-9(1960). (In Russian)

The activation method is suggested for determining microquantities of phosphorus, sulfur, tungsten, molybdenum, and zinc in high-purity selenium and tellurium. The suggested methods of chemical and radiochemical separation are capable of separating preparations of high radiochemical purity with a carrier yield of 25 to 80%. The sensitivity for various elements ranges from 10^{-6} to 10^{-9} g and the order of accuracy for concentrations of 10^{-3} to 10^{-7}% is 10 to 40%. (R.V.J.)

5024 A RAPID METHOD FOR DETERMINING Ra IN WATERS. P. N. Zharov. Radiokhimiya 2, 630-1(1960). (In Russian)

A rapid method for determining radium in water by coprecipitation with calcium carbonate together with activated coal is described. The precipitant is analyzed by dissolving in hydrochloric acid after decantation of the liquid. (R.V.J.)

5025 ANALYSIS OF H_2O AND D_2O MIXTURES BY INFRA-RED SPECTROSCOPY. DETERMINATION OF MOLECULAR EXTINCTION COEFFICIENTS. M. Ceccaldi (Centre d'Etudes Nucléaires, Saclay, France). Rev. universelle mines (9) 15, 7p.(1959) May. (In French). (CEA-1285)

The various conditions for infrared analysis of H_2O-D_2O mixtures are briefly recapitulated. An absolute method for analyzing these mixtures is proposed, and the results obtained by infrared spectroscopy are compared with those obtained by nuclear resonance. Finally a few details of the apparatus used are given: a conventional spectrometer for laboratory determinations and an infrared photometer for continual analysis. (auth)

5026 THE DETERMINATION OF ACTINIUM AND RADIUM BY THE COPPER-SPARK SPECTROGRAPHIC METHOD. F. T. Birks (Atomic Energy Establishment, Harwell, Berks, Eng.). Spectrochim. Acta 16, 1016-21 (1960) Oct. (AERE-C/R-2474)

The copper-spark method is used to detect and measure actinium and radium in mixtures and in liquid wastes. The limits of detection are 0.02 μg of actinium and 0.003 μg of radium in about 0.05 ml of solution. With molybdenum as an internal standard, a coefficient of variation of 7 per cent is obtained for actinium determinations. (auth)

5027 CHEMICAL INSTRUMENTATION. A SYSTEMATIC APPROACH TO INSTRUMENTAL ANALYSIS. Howard A. Strobel. Reading, Mass., Addison-Wesley Publishing Company, Inc., 1960. 667p.

A treatment of instrumental analysis is presented which covers the theory of instrumentation, optical and electric principles, application of these principles to analysis, and radioisotope applications. A large amount of physical theory is discussed as a basis for the applications. An appendix of laboratory experiments is included. (D.L.C.)

General Inorganic and Physical Chemistry

5028 (AAEC/E-45) SEPARATING SMALL PARTICLES FROM LIQUIDS WITH THE HYDROCYCLONE. PART I. CONCLUSIONS AND RECOMMENDATIONS ARISING FROM LITERATURE SEARCH. R. C. Cairns, E. G. Thurstan, and K. S. Turner (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). June 1959. 12p.

A literature search has shown that a two-stage hydrocyclone is required to give maximum concentration simultaneously with maximum clarification. For design purposes it is necessary to consider each operation separately. Concentration and clarification efficiencies have been proposed which will enable a choice of the major dimensions of a hydrocyclone to be made for each operation once experimental data are available for various systems. (auth)

5029 (AERE-R-3497) TABLES OF THE RESISTIVITY OF AQUEOUS SODIUM CHLORIDE SOLUTIONS. G. F. Hewitt (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 17p. BIS.

Tables of the specific resistivity of NaCl solution at 18°C in terms of wt. % are presented. A method for temperature correction is suggested, and tables of temperature coefficients are given. (auth)

5030 (BM-RI-5702) METALLIC REDUCTION OF THORIUM TETRACHLORIDE. P. C. Good and F. E. Block (Bureau of Mines, Albany, Ore.). Mar. 1960. 15p.

A method for preparing thorium metal by the reduction of thorium tetrachloride is described. Thorium tetrachloride was prepared by chlorinating calcined thorium oxalate with carbon tetrachloride. The crude thorium tetrachloride, containing oxygen-bearing compounds, was purified by a double vacuum distillation at 800 to 900°C, and thorium metal was made in the form of a dense sponge by the reaction of metallic sodium or magnesium with thorium tetrachloride at 800°C. Vacuum arc melting was used to consolidate the sponge metal to ingot form for evaluation of its physical and chemical properties. (auth)

5031 (K-1416) SAFE HANDLING OF CHLORINE TRIFLUORIDE AND THE CHEMISTRY OF THE CHLORINE OXIDES AND OXYFLUORIDES. R. Lynn Farrar, Jr. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nov. 11, 1960. 33p. Contract W-7405-eng-26. OTS.

A discussion of the potential hazards of chlorine trifluoride is presented and a series of safe handling procedures is recommended. Particular emphasis is placed on the hazardous chlorine oxides and oxyfluorides which are produced by reaction of chlorine trifluoride with moisture and many oxides. Modification of the procedures for use with bromine trifluoride is included. The report contains a comprehensive literature survey on the preparation, chemical and physical properties, and stability of the individual chlorine oxides and oxyfluorides. (auth)

5032 (NP-9217) PREPARATION OF UO_2- AND ThO_2-POWDERS WITH SPECIFIC PROPERTIES. M. E. A. Hermans and H. S. G. Slooten (Naamloze Vennootschap tot

Keuring van Electrotechnische Materialen, Arnhem, Netherlands). [1959]. 19p.

Presented at the EAES "Enlarged Symposium on Reactor Materials" at Saltsjöbaden, Sweden, October 1959.

Methods for the preparation of UO_2 and ThO_2 powders with defined particle size and shape are described. (C.J.G.)

5033 (NP-9639(Vols. 1 and 2)) JANAF INTERIM THERMOCHEMICAL TABLES. VOLUMES 1 AND 2. T. E. Dergazarian, N. J. Dumont, L. A. du Plessis, W. E. Hatton, S. Levine, R. A. McDonald, F. L. Oetting, H. Prophet, G. C. Sinke, D. R. Stull, and C. J. Thompson (Dow Chemical Co. Thermal Lab., Midland, Mich.). Dec. 31, 1960. 2½ in. thick. Contract AF33(616)-6149.

These two volumes were issued separately, but are cataloged as a unit.

A comprehensive set of thermochemical tables is presented for rocket performance calculations. The tables include data on compounds of Al, B, Be, Ti, Zr, and a number of other compounds. (W.L.H.)

5034 (NSEC-13) RETENTION EFFICIENCIES OF SILVER-COATED FILTER MATERIALS FOR IODINE. R. C. Koch and G. L. Grandy (Nuclear Science and Engineering Corp., Pittsburgh). Sept. 8, 1958. 23p. OTS.

Tests were performed to determine the efficiencies of silver-coated filter materials for removal of iodine from high-velocity air streams. A radioactivity method, using I^{131} as a tracer, was chosen for the evaluation tests. A test apparatus was devised which permitted continuous testing of filter materials under controlled temperatures, pressures, and air flow rates and which provided a quantitative trapping of any iodine released from the filter. Results showed that the filters were highly efficient for removing elemental iodine from high-velocity air streams at 500°F. Tests under other conditions are also recommended. (J.R.D.)

5035 (ORNL-3017(p.42-5)) INVESTIGATIONS OF METAL SURFACES. F. W. Young, Jr., L. D. Hulett, et al. (Oak Ridge National Lab., Tenn.).

The kinetics of the electrochemical dissolution of copper crystals in deaerated $CuSO_4$ solutions are being investigated using a galvanostatic technique. Conditions were defined for the dissolution via a dislocation mechanism; this dissolution leaves pits at points where dislocations intersect the surface. Other conditions of potential and current cause the surface to be faceted by the dissolution, and apparently dislocations are not involved in this mechanism. The kinetics of the dissolution of copper crystals in aerated solutions of HCl are being studied by measuring the change in conductivity of the solution. The experiments are designed to elucidate the role of dislocations and of crystal plane in the chemical reactivity of metal surfaces. A mechanism has been suggested for the development of etch pits at dislocations, and several etch solutions have been found that will satisfactorily form pits at dislocations on the (1 1 1), (1 0 0), and (1 1 0) faces of pure copper. Studies on the growth of more perfect copper crystals and on the surface preparation of such crystals are described. (auth)

5036 (TID-6965) KINETICS OF THE REACTIONS INVOLVED IN THE FERRIC CHLORIDE ETCHING OF COPPER PHOTOENGRAVING PLATES. Quarterly Technical Status Report No. 5 covering Period: July 1, 1960 to September 30, 1960. C. T. Lewis, Jr. and W. H. Burrows (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 10, 1960. 24p. Project No. A-446-2. Contract AT(38-1)-202. OTS.

Sixty-six kinetic runs at 25°C were made studying the effect of varying the concentration of the ferric chloride solution, the solution flow rate, the dissolved gases, and the position of the sample relative to the direction of flow. All experiments were completed by a modified technique outlined in this report. Least square fit methods indicate a fourth order polynomial relationship between the molarity and the dissolution rate. Further studies are in progress to examine the equilibrium of the ferric chloride solutions prior to experimental runs. An inhibitor reaction investigation using S^{35}-labeled thiourea is being planned on a statistical experiment design basis. (auth)

5037 (TID-6976) THE USE OF RADIOISOTOPES IN THE STUDY OF MODIFICATIONS OF PLATINUM CATALYSTS. Quarterly Technical Status Report No. 5 covering Period: July 1, 1960 to September 30, 1960. James A. Stanfield (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 10, 1960. 13p. Project No. A-446-1. Contract AT(38-1)-202. OTS.

Surface areas of platinum oxide (PtO_2) and of reduced platinum catalyst were determined and found to be 34.9 and 8.3 m^2/g, respectively. These areas were determined using the BET method with nitrogen gas. On the basis of the area of the reduced platinum and the ionic radius of the zinc(II) ion, it was calculated that the catalyst surface is covered to the extent of 8%. Explanation of this is given. Correlation between the extent of adsorption of ions and the rate of hydrogenation was also made. It was found, for example, that a maximum rate was obtained when there was adsorbed on the catalyst surface 0.775×10^{-3} mmole of Zn^{+2} ions. When either more or less zinc ions were on the catalyst, a rate lower than 276×10^{-4} $min^{-1}g^{-1}$ resulted. Similarly the correlation of rate with mmoles of zinc salt present in the reaction medium revealed a maximum rate (276×10^{-4} $min^{-1}g^{-1}$) when 2.5×10^{-3} millimole of zinc acetate was added to the reaction mixture. There was no correlation between the per cent of added zinc ions which were adsorbed and the rate constant. Data were also obtained which indicated that the amount of zinc ions found adsorbed on the catalyst surface could be influenced by whether hydrogen or acceptor molecules were present in the system. The amount of adsorption was also shown to be influenced by treatment of the system after conclusion of the hydrogenation. Thus the observed adsorption of zinc ions on the surface was greater when the catalyst was isolated immediately after the conclusion of the reaction, and the amount of adsorption decreased with time lapse between conclusion and isolation up to about 24 hr. Beyond this time, the amount of metal ion adsorbed on the surface did not change further. (auth)

5038 (TID-11085) PREPARATION OF HIGH PURITY YTTRIUM OXIDE FROM METALLURGICAL GRADE YTTRIUM OXIDE BY ION EXCHANGE. Report No. 179. Period [covered]: May 14, 1958 to June 25, 1958. John R. Morton (Michigan Chemical Corp., St. Louis, Mich.). July 29, 1958. 9p. Project No. 942. OTS.

The purification of >99% Y_2O_3 to >99.9% Y_2O_3 by means of ion exchange was studied in the pilot plant using hydroxyethylethylenediaminetriacetic acid (HEDTA) and ethylenediaminetetraacetic acid (EDTA) as eluants. Yttrium oxide of >99% Y_2O_3 purity could not be upgraded to >99.9% Y_2O_3 in one band length using ethylenediaminetetraacetic acid as the eluant. High purity yttrium oxide (>99.9% Y_2O_3) could be obtained in good yield by eluting one band length with hydroxyethylethylenediaminetriacetic acid. The use of hydroxyethylethylenediaminetriacetic acid in purifying >99%

Y_2O_3 to >99.9% Y_2O_3 is recommended for use in the plant. (auth)

5039 (TID-11091) THE PURIFICATION OF METALLURGICAL-GRADE YTTRIUM OXIDE BY LIQUID-LIQUID EXTRACTION. Report No. 216. Period covered: July 18, 1958 to August 8, 1958. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). Jan. 26, 1959. 4p. Project No. 942. OTS.

The purification of metallurgical-grade yttrium oxide by means of liquid-liquid extraction was studied on a 9-stage laboratory semicontinuous extractor. High-purity yttrium oxide was obtained from the organic phase when employing 1.5 to 2.0% hydroxyethylethylenediaminetriacetic acid (HEDTA) buffered at pH's between 4.0 and 5.0 for the aqueous phase scrub. (auth)

5040 (TID-11207) ANNUAL REPORT AND PROPOSAL FOR THE CONTINUATION OF A STUDY ON THE THERMAL CONDUCTIVITY OF INORGANIC MELTS. W. O. Philbrook (Carnegie Inst. of Tech., Pittsburgh. Metals Research Lab.). Dec. 15, 1960. 15p. Contract AT(30-1)-2360. OTS.

Activities in a program to design, construct, and operate a furnace suitable for measuring the thermal conductivities of nonoxidizing melts at 800 to 1200°C are described. A discussion of design aspects is presented, and a summary of completed work is included. Installation of all electrical instrumentation is reported. The graphite cell is completely assembled with installed thermocouples. Other work in progress is described, and plans for future activities are outlined. (J.R.D.)

5041 (TID-11226) STATISTICAL THERMODYNAMICAL THEORY OF SURFACE TENSION. Technical Report No. XXXIX. S. Chang, T. Ree, and H. Eyring (Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes). Dec. 10, 1960. 27p. Project No. 1. Contract AT(11-1)-82. OTS.

A statistical thermodynamic theory of surface tension is proposed which makes use of a liquid partition function developed by other workers. The theory of this function in relation to significant structures of liquids is reviewed, and the proposed theory is outlined. Trial cases are presented in which neon, argon, and nitrogen were used. (J.R.D.)

5042 (TID-11243) POLAROGRAPHIC STUDIES OF RADIOACTIVE ISOTOPES. Progress Report. Ward B. Schaap and Emil Wildman (Indiana Univ. Foundation Research Div., Bloomington). [1960]. 6p. OTS.

An attempt was made to plate radioactive metal ions onto a dropping mercury cathode. A specified number of drops is collected at a particular voltage, and the activity of these drops is measured with an appropriate detecting unit. Initial studies are being made on the most simple systems to see how well the activity-voltage curves correspond to current-voltage curves of the same metal ion. Since this method is current-independent the limitation in concentration is due to the ability to detect the radiation from the drops. Calculations show that it is possible to obtain curves of isotopes of concentration as low as 10^{-10}M. (W.L.H.)

5043 (TID-11246) APPARATUS FOR HIGH PRESSURE POLAROGRAPHY; APPLICATION TO POLAROGRAPHY IN LIQUID AMMONIA AT 25°C. Ward B. Schaap, Robert F. Conley, and F. C. Schmidt (Indiana. Univ., Bloomington). [195?]. 9p. Contract AT(11-1)-256. OTS.

An apparatus is described which allows polarographic studies with a dropping mercury electrode to be made at elevated pressures. The apparatus was tested in polarographic studies in liquid ammonia at 25°C and 10 atmospheres pressure. The apparatus can be used, in general, in the study of polarography in solvents at temperatures above their normal boiling points and allows comparison of polarographic and derived thermodynamic data in different solvents to be made at standard temperatures. (auth)

5044 (AEC-tr-4348) ON THE DIRECT METHOD OF VAPOR PRESSURE DETERMINATION. S. P. Detkov. Translated from Zhur. Fiz. Khim. 34, 1634-7(1960). 8p. JCL or LC.

The direct method of determining vapor pressure consists in measuring of the recoil force of a chamber when a molecular stream leaves the chamber through an opening. The method provides a high degree of accuracy over the pressure range 10^{-7} to 10^{-4} atm and, in combination with other methods, makes it possible to determine the molecular weight of the vapor. The apparatus used for the research consists of a vertical tube, evacuated to a pressure of 10^{-6} mm Hg, along the axis of which is lowered an elastic thread. At the bottom, the thread is soldered to a cross-piece with two effusion chambers, one at each end. During effusion of the vapor molecules, the thread twists. (W.L.H.)

5045 (AEC-tr-4369) THE ELECTRICAL CONDUCTIVITY OF OXIDES. W. Noddack and H. Walch. Translated by Karl S. Vorres (Iowa State Univ.) from Z. Electrochem. 63, 269-74(1959). 19p. JCL.

The electrical conductivities of oxides of the tri- and tetra-valent rare earths and a few heavy metal oxides were measured as a function of the temperature and the applied potential. Conclusions were drawn from the data that were obtained pertaining to the type of conductivity, and relationships were found between the conductivity and the work function as well as the selective radiations from the oxides. (auth)

5046 (AEC-tr-4371) CONDUCTIVITY MEASUREMENTS ON RARE EARTH OXIDES. [PART] I. W. Noddack, H. Walch, and W. Dobner. Translated by Karl S. Vorres (State Univ. of Iowa) from Z. physik. Chem. (Leipzig) 211, 180-93(1959). 19p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 22770.

5047 (CEA-tr-R-940) RAFFINAGE À L'IODURE DU NIOBIUM. (Refining with Niobium Iodide). D. M. Chizhikov and A. M. Grin'ko. Translated into French by Y. Kefeli from Zhur. Neorg. Khim. 4, 982-4(1959). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 4576, Issue 5.

5048 (NP-tr-527) ON THE KINETICS OF CHLORINATION OF TITANIUM DIOXIDE AND NIOBIUM PENTOXIDE. (O Kinetike Khlorirovaniya Dvuokisi Titana I Pyatiokisi Niobiya). I. S. Morozov and S. L. Stefanyuk. Translated from Zhur. Neorg. Khim. 3, 2366-74(1958). 13p. OTS.

The kinetics of chlorination of TiO_2 and NbO_5 in mixtures with carbon was investigated. A relation between the rate of chlorination of these compounds, the temperature, sample briquette dimensions, and partial chlorine pressure was established. (J.R.D.)

5049 (NP-tr-528) A PRIMARY STANDARD FOR ABSOLUTE SPECTROPHOTOMETRIC MEASUREMENTS. G. F. Sitnik. Translated from Doklady Akad. Nauk S.S.S.R. 110, 780-2(1956). 8p. OTS.

An experiment is described in which a model of a black body was produced at high temperatures. (J.R.D.)

5050 (UCRL-Trans-616(L) FOCUSING ION EXCHANGE. III. RAPID SEPARATION OF RADIOACTIVE INDICATORS. (Über Fokussierenden Ionenaustausch. III. Schnelltrennung von Radioaktiven Indikatoren). Ernst Schumacher and Hans Jakob Streiff. Translated from Helv. Chim. Acta 40, 234-6(1957). 7p. JCL.

Tracer quantities of elements can be separated on a paper strip in minutes or less by focusing ion exchange. The time-dependent separation process is followed with a radioactive strontium solution. (W.L.H.)

5051 (UCRL-Trans-617(L)) FOCUSING ION EXCHANGE. V. SEPARATION OF METAL IONS, PARTICULARLY OF RADIOACTIVE INDICATORS, BY PROTON EXCHANGE. E. Schumacher and H. J. Streiff. Translated from Helv. Chim. Acta 41, 824-43(1958). 37p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 11372.

5052 (UCRL-Trans-620(L)) THE ABSORPTION CAPACITY OF SOLID COBALT FOR HYDROGEN AND NITROGEN. (Das Absorptionsvermögen des Festen Kobaltes für Wasserstoff und Stickstoff). A. Sieverts and H. Hagen. Translated from Z. physik. Chem. (Leipzig) 169A, 237-40 (1934). 10p. (Includes original, 4p.). JCL.

The absorption capacity of pure cobalt for hydrogen at atmospheric pressure was determined between 600 and 1200°C. With varying pressure the amount absorbed is proportional to the square root of the hydrogen pressure. The absorption capacity of a commercial cobalt with 2.5% iron scarcely differed from that of pure cobalt. Nitrogen is practically insoluble in cobalt up to 1200°C. (W.L.H.)

5053 DIFFERENTIAL THERMAL ANALYSIS AND THERMOGRAVIMETRIC ANALYSIS OF FISSION PRODUCT OXIDES AND NITRATES TO 1500°C. P. F. Campbell, M. H. Ortner, and C. J. Anderson (Vitro Labs., West Orange, N. J.). Anal. Chem. 33, 58-61(1961) Jan.

Apparatus is described for differential thermal analysis and thermogravimetric analysis in air to 1500°C. This equipment was used to study the thermal stability of strontium oxide, strontium nitrate, cesium nitrate, zirconyl nitrate dihydrate, cerous nitrate hexahydrate, ruthenium dioxide, and mixtures of these materials with alumina. Evidence is presented for the formation of $CsAlO_2$ in the temperature range 940 to 1100°C, and the course of the thermal decomposition of RuO_2 is described. (auth)

5054 ON THE DETERMINATION OF THE HEAT OF FUSION OF ONE OF THE CONSTITUENTS OF A BINARY MIXTURE FROM THE HEAT OF FUSION OF THE OTHER, BY MEASUREMENT OF THE SLOPES OF TWO LIQUIDUS CURVES AT THE EUTECTIC POINT. Maurice Dode and Raoul Hagege. Compt. rend. acad. sci. 248, 2339-41(1959) Apr. 20. (In French). (CEA-1237)

A method for calculating latent heats of fusion from binary diagrams of liquid-solid equilibrium was proposed several years ago. The method is based on the hypothesis of the regularity of the solution in a small region around the eutectic and involves an integration along the liquidus curves slightly extrapolated below the eutectic point. (auth)

5055 REACTIONS WITH N^{15}. XXXIV. SEPARATION EFFECT IN THE ISOTOPES N^{14} AND N^{15} DURING THE ENGINEERING MANUFACTURE OF NITRIC ACID. K. Clusius and U. Piesbergen (Universität, Zurich). Helv. Chim. Acta 43, 1562-9(1960). (In German)

In nitric acid manufacture, the nitrogen was introduced in countercurrent to the absorbing water. The heavy nitrogen isotope N^{15}, with a concentration in air of 0.365%, was reduced to 0.309%. This low N^{15} concentration occurs in the nitrite-nitrate mixture in the alkali absorption tower, whereas the concentrated acid shows approximately the natural N^{15} concentration of the air. The basis for this isotope displacement, which daily comprises many tons of material, is discussed. (tr-auth)

5056 AN INVERSE HYDROGEN ISOTOPE EFFECT IN THE HYDROLYSIS OF SODIUM BOROHYDRIDE. Robert Earl Davis, Charles L. Kibby (Purdue Univ., Lafayette, Ind.) and C. Gardner Swain. J. Am. Chem. Soc. 82, 5950-1(1960) Nov. 20.

The decomposition rate of $NaBD_4$ was measured in aqueous borate buffers under nitrogen at 25°C and compared with the results for $NaBH_4$ hydrolysis under similar conditions. The ratio k_H/k_D was observed to fall in the range of 0.67 to 0.77, and the inverse isotope effect is ascribed to a secondary isotope effect of the other H or D atoms not undergoing the protonolysis reaction in the rate-determining step. The B-H bonds and their stiffness are discussed together with comparisons of the results with these for other compounds. (D.L.C.)

5057 THE DECOMPOSITION OF CRYSTALLINE URANYL OXALATE INDUCED BY REACTOR RADIATION. D. A. Young (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc. 4533-42(1960) Nov. (AERE-C/R-2429).

The decomposition of isotopically-normal and U^{235}-depleted anhydrous uranyl oxalate was studied under various conditions of reactor and γ irradiation. The products are carbon monoxide and carbon dioxide in the ratio of about 1:3 with a solid residue of approximate composition $UO_{2.8}$, which is more reactive than the corresponding macroscopic oxide prepared by low-temperature reduction of the trioxide. Some separation of the contributions to the decomposition by recoiling fission fragments, fast neutrons, β-particles, and reactor γ rays was effected. For recoiling fission fragments, the G-value and the number of oxalate molecules decomposed per fission are respectively 5.1 and 8200×10^3; the corresponding figures for reactor γ rays are 0.1 and 3×10^3. The form of the decomposition-dose curve is accurately given by a first-order expression, and this is interpreted to mean that decomposition occurs where fission-recoil tracks traverse virgin reactant. The thermal decomposition of uranyl oxalate is enhanced by a small degree of preirradiation. The kinetics of this effect are discussed on a topochemical model. (auth)

5058 CHROMATOGRAPHY ON PAPER IMPREGNATED WITH ZIRCONIUM PHOSPHATE. G. Alberti and G. Grassini (Comitato Nazionale per le Ricerche Nucleari, Rome). J. Chromatog. 4, 83-5(1960). (In English) (CNG-58)

Zirconium phosphate impregnated paper was prepared by precipitating zirconium phosphate directly into the paper fibers. R_f values and chromatographic separations of different cations on this paper are reported. (auth)

5059 THE INFLUENCE OF WATER AND ACID CONCENTRATION ON THE CHROMATOGRAPHIC BEHAVIOUR OF INORGANIC IONS. R. Guedes de Carvalho (Centro de Estudos de Quimica Nuclear, Oporto, Portugal). J. Chromatog. 4, 353-68(1960) Nov. (In English)

The shape of the curves of R_F vs. acid and water concentration of the eluant was investigated using mixtures of HCl, H_2O, and n-butanol as eluants. In this way the best conditions for separation were determined, and similari-

ties among various elements were established. The influence of water and acid concentration on the chromatographic behavior of Rb, Cs, Cu, Au, Be, Mg, Cd, Zn, Hg, La, Th, Ga, In, Tl, Ge, Sn, Pb, V, Sb, Bi, Cr, Mo, U, Se, Te, Re, Mn, Co, Ni, Fe, Ti, Zr, and Pt was determined. (M.C.G.)

5060 THE DISSOCIATION ENERGIES OF THE H_2, HD, AND D_2 MOLECULES. G. Herzberg and A. Monfils (National Research Council, Ottawa). J. Mol. Spectroscopy 5, 482-98(1960) Dec.

The far ultraviolet absorption edges of H_2, HD, and D_2 were studied under high resolution and the different limits corresponding to absorption from different lower state rotational levels were observed. The sharpness of the limits for low, as compared to those for high J values, shows that the upper electronic state (which in all probability is the $C\ ^1\Pi_u$ state) has no potential maximum which might have falsified the values of the dissociation limit. From the precisely measured edges new values for the dissociation energies of H_2, HD, and D_2 were determined which are: $D_0^0(H_2) = 36113.0 \pm 0.3\ cm^{-1}$, $D_0^0(HD) = 36399.3 \pm 1.0\ cm^{-1}$, and $D_0^0(D_2) = 36743.6 \pm 0.5\ cm^{-1}$. If $B'\ ^1\Sigma_u$ rather than $C\ ^1\Pi_u$ is the upper state of the continuum, these values would have to be raised by $0.6\ cm^{-1}$. The zero-point energies of the three molecules were determined from recent data including the correction term Y_{00} because of the finer interaction of vibration and rotation. The addition of these zero-point energies to the D_0^0 gives independent D_e values for the three molecules. A slight difference between $D_e(H_2)$ and $D_e(D_2)$ was found which is ascribed to an electronic isotope effect caused by a difference in the effect of nuclear motion in the molecule from that in the separated atoms. The magnitude of the effect is in agreement with predictions by Van Vleck. After correction for this effect one obtains the dissociation energy for infinite mass $D_e(^\infty H_2) = 38287.0 \pm 0.8\ cm^{-1}$, a value that agrees extremely well with Kolos and Roothaan's recent theoretical value. (auth)

5061 KINETICS OF U(IV) OXIDATION BY CHLORATES, AMMONIUM PERSULFATES, AND HYDROGEN PEROXIDE. E. A. Kanevskiĭ and L. A. Fedorova. Radiokhimiya 2, 559-67(1960). (In Russian)

Oxidation of U(IV) by $KClO_3$, $(NH_4)_2S_2O_8$, and $HClO_3$ in sulfuric acid is a reaction of the first order in relation to uranium and of fractional order in relation to ClO_3^- and H^+. Empirical formulas are developed for the rate of the process. The rate of U(IV) oxidation by hydrogen peroxide is very rapid; advanced mixing of the solution influences the kinetics of the process. The oxidation rate by peroxide is limited by diffusion; whereas in oxidation with perchlorate and persulfate, the process is limited by oxidation. (R.V.J.)

5062 THE OPTICAL SPECTRA OF PLUTONIUM IN THE 1-2.5 μ REGION. L. Bovey and E. B. M. Steers (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Spectrochim. Acta 16, 1184-99(1960) Nov.

Details of the 100-cm focus (f/7 aperture) plane grating spectrometer built for the investigation of the 1-2.5 μ region are given. Among the sources used were a vacuum furnace, a positive column discharge, and microwave excited tubes; the last were most useful. A method to reduce continuous background (by pulsing the magnetron which supplies the microwave power) is noted. The problem of accurate wavelength measurement in the region is considered, and the use of overlapping orders of visible light fringes is described. A list of the wavelengths and intensities for plutonium lines emitted from a microwave excited discharge is included. (auth)

5063 PREPARATION AND PROPERTIES OF NEODYMIUM BORIDES. G. V. Samsonov, Yu. B. Paderno, and V. S. Fomenko. Voprosy Poroshkovoĭ Met. i Prochnosti Materialov, Akad. Nauk Ukr. S.S.R. No. 8, 66-8(1960). (In Ukrainian)

Preparations of neodymium hexaboride by oxide reduction with boron carbide, $Nd_2O_3 + 3B_4C \rightarrow NdB_6 + 3CO$, and by direct reduction of the oxide by boron, $Nd_2O_3 + 15B \rightarrow NdB_6 + 3BO$ at 1100 to 1800°C, are described. The x ray diffraction diagram of neodymium hexaboride is presented and the physical properties are analyzed. (R.V.J.)

5064 PHASE BEHAVIOR AND ORDER STATE OF CERIUM HYDRIDE. R. Streck and K. Dialer (Max Planck Inst. für Kohlenforschung, Mülheim, Ger. and Farbwerke Hoechst AG, Frankfurt am Main). Z. anorg. u. allgem. Chem. 306, 141-58(1960) Oct. (In German)

Activated metallic cerium reacts with purest hydrogen at low temperatures and normal pressure yielding finally CeH_3. Above the composition $CeH_{1.8}$ there is only one phase to which the formula of the dihydride is assigned. CeH_2, with a cubic face-centered coördination of the metal atoms, takes up further hydrogen forming the isomorphic trihydride. Neither a mono- nor a sesquihydride exists. According to the preparation conditions, the hydride phase is more or less disordered. The disorder arrangement influences the dissociation pressures, the heats of formation, the reactivities, and the sharpness of the powder diagram lines. (auth)

Radiation Chemistry and Radiochemistry

5065 (NYO-2527) A STUDY OF THE MECHANISM OF RADIATION INDUCED REACTIONS OF ORGANIC POLYMERS WITH INORGANIC SALTS AND ORGANOMETALLIC COMPOUNDS. Quarterly Summary Report [for] July 1, 1960 to September 30, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Nov. 4, 1960. 6p. Contract AT(30-1)-2318. OTS.

Preliminary results of the grafting of methyl acrylate to polyethylene and to teflon in methanol are reported. The accelerative effect of methanol on the grafting of styrene to nylon was found to be due to the fact that the styrene available for the reaction is in greater concentration in the styrene-methanol mixtures than in pure styrene. Graft polymers of diallylphosphite and vinyl stearate to polyethylene were prepared. (For preceding period see NYO-2525.) (C.J.G.)

5066 (ORNL-3017(p.101-3)) POLYMERS. W. W. Parkinson, D. Binder, et al. (Oak Ridge National Lab., Tenn.).

The relative effectiveness of reactor and γ radiation in producing cross links in polystyrene was investigated by molecular weight measurements. The intensities of the γ sources were measured with ceric sulfate, while the intensity of the reactor radiation was determined independently by calorimetric measurements. Apparently reactor radiation cross-links polystyrene 3.3 times as fast as γ radiation alone. The infrared spectrophotometer used to measure radiation-induced changes in molecular structure was calibrated for olefinic groups by measurement of solutions of hydrocarbon standards in carbon disulfide. Equations for the infrared absorption coefficients were calculated with the Oracle using the least-squares method of curve fitting. These equations will be formulated into a

system of simultaneous equations to be solved for the concentrations of isomeric olefin groups in irradiated specimens that contain several such groups. (auth)

5067 (RICC-64) UNE SOURCE RESERVOIR A FRANCIUM 223. (A Source Container for Francium 223). J. Fouagre (Liège. Université) and W. W. Meinke (Michigan. Univ., Ann Arbor). [1960]. 18p. OTS.

Presented at "Conference sur l'Emploi des Radioisotopes dans les Sciences Physiques et dans l'Industrie, Copenhague, 6-17 Septembre 1960."

A process for the preparation of Fr^{223} is described. A column filled with 2.5 g cellulose + 0.25 g of ZrO_2 is loaded with Ac^{227} and rapidly eluted (eluant pressure = 1.5m) with phenol equilibrated with 2N HCl and finally with 10% H_2O_2. The Fr comes out at 4.5 to 9 min. A triple extraction with ether equilibrated with water separates the phenol. Ether is boiled off the small aqueous phase; and drops of H_2SO_4 and $BaCl_2$ are added, followed by centrifugation. The operation takes 20 to 22 min and should be repeated after 1 or 2 hr. (T.R.H.)

5068 (TID-6954) DEAGGLOMERATION OF KAOLIN BY HIGH-ENERGY, IONIZING RADIATION. Quarterly Technical Status Report No. 5 Covering Period: July 1, 1960–September 30, 1960. William J. Corbett and John H. Burson, III (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 10, 1960. 10p. Project No. A-446-5. Contract AT(38-1)-202. OTS.

Research performed on this project during the period covered by this report was concerned with the redetermination of the variation of crystallinity index, the variation of infrared adsorption spectrum, and the variation of cation-exchange capacity of kaolin with varying doses of γ radiation. The research performed has also been concerned with the effects of wet grinding on samples of kaolin that have received various doses of γ radiation. The particle size distributions of these wet-ground samples were determined with the Coulter Counter. The index of crystallinity of kaolin does not show a definite trend with increasing doses of γ radiation, but instead appears to fluctuate from higher to lower and back to higher degrees of crystallinity. This fluctuation is the result of difficulties in resolving one of the necessary relections used for computing the crystallinity index. The infrared adsorption spectra of kaolin do not appear to change with exposure to γ radiation. The cation-exchange capacities of samples of kaolin increase with increasing doses of γ radiation. Samples of kaolin that have been subjected to shearing along the kaolinite cleavage plane through wet grinding show no significant difference in particle size reduction for increased doses of γ radiation. (auth)

5069 (TID-11253) RADIATION-INDUCED CYANOGENATION OF ORGANIC COMPOUNDS. Quarterly Technical Status Report No. 2 Covering the Period August 1, 1960–October 31, 1960. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 12p. Project No. A-446-8. Contract AT(38-1)-202. OTS.

Emphasis was placed on the irradiation of a number of cyanogen-organic mixtures and analysis of the irradiated mixtures, primarily for presence of cyano products. The organic compounds that were irradiated in admixture with cyanogen are benzene, toluene, n-heptane, cyclohexane, and 2,2,4-trimethylpentane. From infrared analysis of the irradiated mixtures, evidence exists that radiation-induced cyanogenation has occurred with toluene, n-heptane, cyclohexane, and 2,2,4-trimethylpentane. There is no indication that radiation-induced cyanogenation occurred with benzene under the conditions employed. In order to carry out irradiations at higher concentrations of cyanogen, and consequently higher pressures, careful consideration was given to the use of a stainless-steel bomb with appropriate fittings. This equipment is presently being procured. Solubility determinations of cyanogen in a number of organic compounds to be used in irradiations were made. Attention is being given to various materials that can be used for chromatographic packings and columns with cyanogen. (auth)

5070 (CEA-tr-R-1000) ETAT DES MICROQUANTITÉS DE RADIOÉLÉMENTS ARTIFICIELS DANS LES SOLUTIONS. XIII. ETUDE DE L'ÉTAT DU POLONIUM DANS LES SOLUTIONS AQUEUSES PAR LES MÉTHODES D'ULTRAFILTRATION ET D'ADSORPTION PAR LE VERRE. (State of Microquantities of Artificial Radioelements in Solutions XIII. Study of the State of Polonium in Aqueous Solution by the Methods of Ultrafiltration and Adsorption by Glass). I. E. Starik and N. I. Ampelogova. Translated into French by S. Szysman from Radiokhimiya 1, 425-9(1959). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5148.

5071 (UCRL-Trans-606) THE DIRECT EFFECTS OF X-RAYS UPON PROTEINS, PEPTIDES, AND AMINO ACIDS. II. INVESTIGATION OF PEPTIDES AND AMINO ACIDS. Boris Rajewsky and Klaus Dose. Translated from Z. Naturforsch. 12b, 384-93(1957). 13p. JCL.

An attempt is made to survey the radiochemical changes produced in natural amino acids and peptides by irradiation of the dry crystalline substance. All the amino acids normally occurring in proteins and the following hydrolyzed peptides were irradiated: glutathione red, glycylvalalanine, triglycine, phalloidine, γ-glutamylalanine, and N-benzoylalanine. The results are discussed as decarboxylation, dehydrogenation, radiochemical splitting-off of H_2O from serine and of H_2S from cysteine, formation or destruction of an aliphatic carbon bond, or studies of peptides. (T.R.H.)

5072 LOW-LEVEL RADIOCHEMICAL SEPARATION OF MANGANESE. J. M. Matuszek, Jr. and T. T. Sugihara (Clark Univ., Worcester, Mass.). Anal. Chem. 33, 35-6 (1961) Jan.

A radiochemical method for separating manganese is based on the extraction of tetraphenylarsonium permanganate into nitrobenzene. The technique indicates speed and specificity. Pertechnetate, perrhenate, periodate, and perchlorate are removed in preliminary steps. The method was used in a search for a long-lived Cr^{51} (auth)

5073 LABELING OF ORGANIC COMPOUNDS BY RECOIL METHODS. Alfred P. Wolf (Brookhaven National Lab., Upton, N. Y.). Ann. Rev. Nuclear Sci. 10, 259-90 (1960). (BNL-4724)

A review is presented of work done on recoil C^{14} and recoil tritium, with emphasis on how these processes can be applied to the labeling of organic compounds. The vast majority of work with other elements has been done with a view toward understanding the mechanisms involved. Allied fields are mentioned insofar as they may have some application to the use of recoil fragments for labeling or to understanding the processes involved. 179 references. (B.O.G.)

5074 PRODUCTION, PREPARATION, AND DELIVERY OF RADIOACTIVE ISOTOPES. J. J. Arlman (Philips'-Duphar N. V., [Eindhoven, Netherlands]). Atoomenergie 2, 162-72(1960) Oct. (In Dutch)

A survey is given of the various problems connected with the production and preparation of radioisotopes. Both

reactor irradiation and cyclotron reactions were considered. (tr-auth)

5075 DECAY OF FREE RADICALS IN γ-IRRADIATED POLYMETHYL METHACRYLATE. Jiro Higuchi, Shōji Shida, Riichiro Kusaka, and Teruo Miyamae (Tokyo Inst. of Tech., and Japan Electron Optics Laboratory Co., Ltd., Tokyo). Bull. Chem. Soc. Japan 33, 1232-3(1960) Sept. (In English)

A preliminary study is reported on the decay of radicals produced in γ-irradiated polymethyl methacrylate (PMMA) above and below the transition point by electron spin resonance (ESR) techniques. The decay of the radicals was investigated between 50 and 80°C. The variation of the relative concentration of free radicals is given as a function of time. The results suggest that the investigation of radical decay in γ-irradiated polymers gives information concerning the motion of polymers. (B.O.G.)

5076 ISOTOPIC EXCHANGE OF GALLIUM BETWEEN THE GALLIUM(III) ION AND ITS ETHYLENEDIAMINE-N,N,N',N'-TETRAACETATE AND N-2-HYDROXYETHYL-ETHYLENEDIAMINE-N,N',N'-TRIACETATE IN AN AQUEOUS SOLUTION. Kazuo Saito and Michiko Tsuchimoto (née Tamura) (Univ. of Tokyo). Bull. Chem. Soc. Japan 33, 1315(1960) Sept. (In English)

As an extension of a study of the isotopic exchange of metal chelate compounds having d^{10} structures, an examination was made of the exchange kinetics of gallium between gallium(III) ions and its EDTA and EDTA-OH complexes in water using Ga^{67}. The result is quite different from that for the corresponding exchange of indium. The rate is very small in a neutral or an acid solution of pH more than 2, and is very great in a basic medium. Data are tabulated for the dependence of the exchange constant, R, on gallium ion and chelate concentrations, rate constant, activation energy, frequency factor of the rate constant, and the entropy of activation. It is suggested that the attack of the hydroxyl ion upon the central gallium in the coordination compound might assist in determining the exchange rate. (B.O.G.)

5077 METHOD FOR THE PURIFICATION OF ASTATINE AND REMARKS ON ITS REDUCTION TO ASTATIDE. Marc Lefort, Gabriel Simonoff, and Xavier Tarrago (Faculté de Sciences, Orsay, France). Bull. soc. chim. France No. 10, 1726-27(1960) Oct. (In French)

The procedures for the separation and purification of astatine produced by nuclear reactions on thorium are described. The astatine is first precipitated by stannous chloride in the presence of tellurium and then by sulfur dioxide. The tellurium is eliminated by sodium stannite in alkaline medium, and the astatine is deposited on silver foil in acid solution. The method separates the astatine from all the elements between phosphorus and uranium, and the impurities have a concentration less than $1/1000$. It was shown during the course of this study that SO_2 reduces astatine to the elemental state and not to the astatide as has been suggested. (tr-auth)

5078 AN INVESTIGATION INTO THE INFLUENCE OF THE SPECIFIC RADIOACTIVITY OF CERIUM OXALATE ON ITS SOLUBILITY. Vict. I. Spitsyn and N. G. Moshchanskaya (Inst. of Physical Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 859-61 (1960) Aug. 1. (In Russian)

The influence of specific radioactivity on the aqueous solubility of cerium oxalate was determined. Preparations of four activity levels, 0.0075, 0.046, 0.495, and 4.3 mc/g, were used in the experiments. The results indicate that with increased specific activity cerium oxalate solubility is reduced. The solubility at small specific activity, $N = 1.0 \times 10^{-6}$ mc/g, the solubility L = 1.65 mg/l, in good agreement with 1.32 and 1.45 mg/l, respectively, is obtained by volumetric and weighing method. (R.V.J.)

5079 KINETIC ISOTOPIC EFFECTS OF TRITIUM IN A LIQUID-PHASE REACTION OF HYDROCARBONS WITH FREE METHYL RADICALS. V. L. Antonovskiĭ and I. V. Berezin (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 134, 860-3(1960) Oct. 1. (In Russian)

Kinetic isotopic effects of H^3 and regularities in their variations were studied as functions of the structure of reacting particles, temperature, etc. An attempt was made to determine the intermolecular kinetic isotopic effects of H^3 in hydrocarbon reactions with free methyl radicals ($i = k^H/k^T$): $RH + CH_3\cdot \xrightarrow{k^H} R\cdot + CH_4$, $RT + CH_3\cdot \xrightarrow{k^T} R\cdot + CH_3T$. Acetyl peroxide was used as the source of methyl radicals. Methyl radical concentrations depend on the extent of peroxide decay and the initial concentration. Tests with benzene-t at 85°C indicate that the magnitude of the isotopic effect does not depend on either the initial concentration or acetyl peroxide decay. Identical results were obtained in experiments with toluene at 55, 70, and 85°C. The ratio $\lg k^H/k^T$ to $1/T$ is linear in character; the magnitude of the ratio A^H/A^T and activation energy differences ($E^T - E^H$) calculated by the smallest squares method are tabulated. The magnitude of the kinetic isotope effect depends on the character of broken bonds and the type of attacking particle. The obtained values are considered as upper boundary values of kinetic isotopic effects of H^3 with free radicals. (R.V.J.)

5080 CHEMICAL DISPLACEMENTS OF F^{19} NUCLEAR MAGNETIC RESONANCE IN ORGANOFLUORINE COMPOUNDS. Yu. S. Konstantinov (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 134, 868-70(1960) Oct. 1. (In Russian)

Investigations were made of the nuclear magnetic resonance spectra of F^{19} in fluoroorganic molecules with known structures. The data verified the chemical shift range for previously investigated groups and contain shift values for previously unknown groups, among them CF_2H^-, CFH^-, and CFH_2^-. The measurements were made with a synchronized autodyne spectroscope with a resolving power of $\Delta H/H \cong 10^{-6}$. The smallest shift was found for fluorine in the group $-C\overset{O}{\underset{F}{<}}$, the largest in CFH_2. In the CF_2H^-, CFH^-, and CFH_2 groups the shift increases with the increase of atomic hydrogen per atom of fluorine (n_H/n_F). In the group $C-CF_2-OR$ the shift magnitude depends on R. The data can be used for determining the relation between the chemical shift for a given group and the composition of the adjacent groups. (R.V.J.)

5081 RADIATION REDUCTION OF TRIVALENT IRON IONS IN SOLUTIONS SATURATED WITH HYDROGEN UNDER PRESSURE. V. N. Shubin and P. I. Dolin (Inst. of Electrochemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 134, 891-4(1960) Oct. 1. (In Russian)

The reduction of trivalent iron in acid solution by γ radiation at various concentrations of H_2, Fe^{3+}, and acid was investigated. The dependence of yield on H_2 pressure was determined for 2×10^{-3} M Fe^{3+} solution in 0.8 N H_2SO_4. The data show that the reduction increases with increased pressure. The yield was independent of Fe^{3+} concentration in 0.8 N H_2SO_4 saturated with H_2 under 50 atm pressure. The reduction dependence on H_2SO_4 and $HClO_4$ concentra-

tions in solutions containing admixtures $NaSO_4$, $NaHSO_4$ is plotted. (R.V.J.)

5082 ION FOCUSSING EXCHANGE. IX. PREPARATION OF SHORT-LIVED, CARRIER-FREE ACTIVITIES OF Sr^{90}, La^{140}, AND Pr^{144} OF HIGH RADIOCHEMICAL PURITY FROM FISSION PRODUCTS. Ernst Schumacher and Walter Friedli (Universität, Zurich). Helv. Chim. Acta 43, 1706-14(1960). (In German)

Y^{90}, La^{140}, and Pr^{144} were prepared with radiochemical purities of 99.992%, 99.95%, and 98.6%, respectively, from their parent fission products: Sr^{90}, Ba^{140}, and Ce^{144}. The procedure of ion focusing for this purpose is described. The results are obtained with a separation time of 3 min. for Y^{90} and La^{140}, or 10 min for Pr^{144}, with radiochemical yields of over 99%. Double separation in 6 min leads to Y^{90} with less than 0.01 μc Sr^{90}/curie Y^{90}, which offers a new possibility for the production of sources for β therapy. Pr^{144} is obtained with less than 1 part Ce^{144} in 5000 parts Pr^{144} in 15 min. (auth)

5083 RADIATION-CHEMISTRY CONVERSIONS OF ORGANIC SUBSTANCES. 4. CONVERSION OF ETHYLENE–OXYGEN MIXTURES BY FAST ELECTRONS. B. M. Mikhailov and V. G. Kiselev (Zelenskii Inst. of Organic Chemistry, Academy of Science, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk No. 9, 1619-28(1960) Sept. (In Russian)

Effects of total radiation dosage, temperature, container material, and initial gases on ethylene oxidation were determined. Radiolytically oxidized ethylene transforms into glycol aldehyde, formic acid, organic peroxide, carbon monoxide, and acetylene. The reaction does not depend on the temperature. The oxidation process in glass, aluminum, and steel chambers is almost identical, while in brass chambers the process undergoes considerable changes. Catalytic effects of the chamber walls were observed at the initial stages of the reaction. The mechanism of additional ethylene transformations is discussed. (R.V.J.)

5084 RADIOLYSIS OF LIQUID NEOPENTANE. William H. Taylor, S. Mori, and Milton Burton (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc. 82, 5817-20(1960) Nov. 20.

The products of radiolysis of liquid neopentane by Co^{60} gammas in the range −196 to 50°C include, among compounds determinable by gas chromatography, ethane, ethylene, propane, propylene, isobutane, isobutylene, isopentant, neohexane, branched octanes, nonanes, dineopentyl, and possibly acetylene. Hydrogen and methane are also found. The major product other than methane, ethane, isobutane, and neohexane show minimum G values around −78°C. The values of $G(CH_4)$ are higher than those previously reported by Hamashima, Reddy, and Burton. Failure of carbon–hydrogen balance is attributed not merely to inaccuracies of analysis but also to possible formation of products higher than decanes. In some experiments, with iodine as solute, the C_3, C_4, and C_{10} products are completely absent, and H_2 and CH_4 are reduced in yield. The other products, C_8 and below, including ethane, are unaffected. Two conclusions regarding the mechanism of radiolysis are that (1) both free-radical and excited molecule reactions appear to be involved, and (2) a significant fraction of the CH_4 may be formed by primary rearrangement decomposition, such as suggested also by the results of Dewhurst on neohexane, who reports that CH_4 production is not completely eliminated by iodine addition. Ion-molecule reactions may also participate. (auth)

5085 KINETIC ISOTOPE EFFECTS IN THE ADDITION REACTIONS OF OLEFINS UNDER ACID CONDITIONS. J. S. Coe and V. Gold (King's Coll., London). J. Chem. Soc. 4571-4(1960) Nov.

The hydrogen isotope effect for solvent addition to propene in 90% aqueous formic acid at 100° (k_H/k_T) has been found to be ~4.5. The differences between this result and those of other workers are discussed on the basis that the isotope effect is in the main determined by the zero-point energy of the H–X bond from which a proton (triton) is transferred to olefin during the first phase of the addition reaction. (auth)

5086 STUDIES ON RADIOLYSIS OF AMINO ACIDS AND PROTEINS. I. ON RADIOLYTIC OXIDATION OF SULFHYDRYL GROUPS. Hiroyuki Hatano (Kyoto Univ.). J. Radiation Research (Japan) 1, 23-7(1960) June. (In English)

By relatively small doses of γ irradiation, inactivation of sulfhydryl enzymes, such as alcohol dehydrogenase and urease, were proved to be induced. This inactivation was recovered reversibly by the addition of thiol compounds such as cysteine and glutathione. In the course of radiolysis of cysteine, measurable decrease in the amount of sulfhydryl group was found to occur by the small doses of the irradiation and, of course, by large irradiation doses. Such decrease in the amounts of sulfhydryl group was found to occur also on the sulfhydryl enzyme proteins. Moreover, the lost activities in the inactivation of the enzymes was proved to be corresponding to the decrease of the sulfhydryl groups. A valid evidence, thus, was added to the mechanism of inactivation of sulfhydryl enzymes by ionizing radiation. (auth)

5087 STUDIES ON RADIOLYSIS OF AMINO ACIDS AND PROTEINS. II. ON RADIOLYTIC DEAMINATION OF AMINO ACIDS IN AQUEOUS SOLUTIONS BY GAMMA IRRADIATION. Hiroyuki Hatano (Kyoto Univ.). J. Radiation Research (Japan) 1, 28-37(1960) June. (In English)

Radiolytic deamination of amino acids in aqueous solutions by γ irradiation was studied. Ammonia yield by the deamination of amino acids was observed to remain almost constant for a wide range of irradiation doses. The yield was also found to increase with the increase concentration of the amino acid. Radiosensitiveness of α-amino acid to the deamination was proved to be larger than that of β-amino acid. ω-Amino acid seems to be very resistant to γ rays and an amino group of amino sulfonic acid was more stable than that of amino carboxylic acid. α-Keto acid was found to be produced from its parent amino acid by γ irradiation in the aerated aqueous solution. Pyruvic acid, α-keto-isovaleric acid and α-ketoglutaric acid were identified from characteristics of ultraviolet absorption spectra and chromatographic behaviors of their corresponding 2,4-dinitrophenylhydrazones. The reaction yield of α-ketoglutaric acid obtained from glutamic acid by γ irradiation was found to vary with γ-ray doses exponentially The yield of decomposed α-alanine was identical stoichiometrically with that of liberated ammonia. The yield of pyruvic acid found from alanine, however, was not the same as of decomposed alanine. The reaction product of leucine with hydrogen peroxide or with a Fenton's reagent was somewhat different from that with γ irradiation. From these results a mechanism of oxidative deamination of amino acid was proposed. (auth)

5088 STUDIES ON RADIOLYSIS OF AMINO ACIDS AND PROTEINS. III. ON RADIOLYSIS OF PEPTIDES AND PROTEINS IN AQUEOUS SOLUTIONS BY GAMMA

IRRADIATION. Hiroyuki Hatano (Kyoto Univ.). J. Radiation Research (Japan) 1, 38-45(1960) June. (In English)

Several peptides and proteins were irradiated by γ rays in aqueous solutions. Radiolytic deamination of peptides and related nitrogenous compounds was found to occur in the air-containing solutions by γ irradiation. To the liberation of ammonia, not only free amino group but also peptide bond were proved to contribute. Moreover, in the course of radiolysis of the peptides, corresponding keto acids to constituent amino acids of peptides, were produced in the γ-irradiated peptide solutions. They were determined quantitatively by column chromatography of their 2,4-dinitrophenylhydrazones. It was shown that aspartic acid is formed from glycine in acetic acid solution by γ irradiation under oxygen-free condition. To the mechanism of radiolysis of peptides and proteins, a valid evidence, that organic free radical produced by γ irradiation might play an important role in the progress of reactions, was presented. From these facts, together with previous results, a scheme of radiolysis of proteins, was proposed and discussed. (auth)

5089 THE PROCESSING OF ENRICHED URANIUM OXIDE/PARAFFIN WAX MIXTURES. L. D. Huckstepp and G. V. Day (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Powder Met. No. 6, 150-9 (1960).

A process for the production of 1-in. cubes in an inert gas atmosphere from enriched uranium oxide and paraffin wax powder mixtures is described. A general description of the type of equipment used is given, and the procedure and safety precautions required for handling this type of radioactive material are outlined. (auth)

5090 ON THE THIOCYANATE IN $K_2[Pt(SCN)_4]$ AND $K_2[Pt(SCN)_6]$. A. A. Grinberg and S. S. Borzakova. Radiokhimiya 2, 574-83(1960). (In Russian)

The systems $K_2[Pt(SCN)_4]$ + 4 KS*CN and $K_2[Pt(SCN)_6]$ + 6 KS*CN were studied, and the influence of time, complex concentration and concentration of free thiocyanate ions on isotopic exchange was analyzed. It is shown that the half-exchange period T in $[Pt(SCN)_4]^{2-}$ + S^*CN^- (or SC^*N^-) at 22°C (concentration of $K_2Pt(SCN)_4 = 0.5 \times 10^{-2}$ M and concentration of $S^*CN^- = 2 \times 10^{-2}$ M) is about 6 to 7 min. In the $[Pt(SCN)_6]^{2-}$ + S^*CN^- system (concentration of $[Pt(SCN)_6]^{2-} = 0.5 \times 10^{-2}$ M and $KS^*CN = 3 \times 10^{-2}$ M), at the same temperature the half-exchange period is nearly 19 min. The rate of exchange in the thiocyanate platinate system varies in proportion to the second order of complex concentration and free thiocyanate ion. In the thiocyanate platinate system the exchange rate has a first-order dependence on free thiocyanate ion concentration and a 1.6 order dependence on complex concentration. (R.V.J.)

5091 INFLUENCE OF SOLVENT ON THE RATE OF ISOTOPIC EXCHANGE IN COMPLEX PLATINUM COMPOUNDS. A. A. Grinberg and L. E. Nikol'skaya. Radiokhimiya 2, 584-91(1960). (In Russian)

The half-exchange period of thiocyanate ion in $K_2[Pt(SCN)_4]$ in an acetone solution at identical concentrations and temperatures is about 340 times greater than in water. The exchange rate in acetone at complex concentration 0.55×10^{-2} M and KSCN concentration 2.2×10^{-2} M is 0.3×10^{-5} g-ion SCN/l/min. A certain dependence of exchange on concentration of the addend was observed. The difference between exchange in acetone and water is explained by their difference in penetrating the complexes and by the magnitude of their dielectric penetrability. (R.V.J.)

5092 VALENCIES OF RADIOACTIVE IODINE ISOTOPES PRODUCED IN TELLURIUM, CESIUM, AND IODINE SPALLATION BY HIGH ENERGY PROTONS. N. G. Zaĭtseva and Wêng-chuang Lo. Radiokhimiya 2, 614-23(1960). (In Russian)

An analysis of the valencies of radioactive iodine isotopes produced by the deep spallation of tellurium, cesium, and iodine by 660 Mev protons shows that the chemical composition of targets, the intensity of the proton beam, and the presence of humidity and air influence the relative yield of radioactive iodine. Radioactive iodine stabilizes in the lower valencies (I_2 and I^-) during irradiation of dried and degassed telluric acid and cesium compounds. The yield of oxidized radioactive isotopes (IO_4^- and IO_3^-) increases in the presence of adsorbed humidity and air. In cesium and iodine salt irradiations by reduced proton intensity and in the absence of humidity and oxygen, the yield of oxidized iodine increases. The isotopic content of all valencies was identical. (R.V.J.)

5093 IONIZING RADIATIONS AND HIGH POLYMERS. A. Lamm (Centre d'Etudes Nucléaires, Saclay, France). Rev. gén. caoutchouc 37, 71-7(1960). (CEA-1446)

After a discussion of high energy radiations and the principal units, mechanisms which govern the modifications of monomers and polymers subjected to irradiation are examined. Examples dealing with the irradiation of polymers in the solid state, with graffed copolymers are given along with the various ways in which they are obtained. This gives a better understanding of the radiation chemical processes of reactors. (auth)

5094 IMPROVEMENTS IN OR RELATING TO CHEMICAL REACTIONS. Roger Fernand Robert Coekelbergs, Frederic Francois Albert Braconier, and Pierre Alexandre Gosselain (to Societe Belge de l'Azote et des Produits Chimiques du Marly). British Patent 852,692. Oct. 26, 1960.

A process for effecting gaseous chemical reactions with the energy of fission products is presented which uses microporous fissionable material of large specific surface ≥100 m^2/g. In this way, it is possible to induce reactions and at the same time have an adequate fuel density for use in a power reactor to extract the unused power. Several methods of preparing microporous fuels containing uranium are given using coprecipitation, impregnation, etc. Data are presented on the characteristics of fuel prepared in this way with activated carbon, silica, and alumina carriers. The effects of specific surface of fuel and reactant pressure on the efficiency of N_2O decomposition are graphically illustrated. (D.L.C.)

Raw Materials and Feed Materials

5095 (NP-9638) MONTHLY REPORT OF DEVELOPMENT [FOR] NOVEMBER 1960. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 22p.

Results of carbonate leach tests on mill samples are reported. Results of acid bake-leach tests on Beaverlodge ore are reported. A series of uranium precipitation tests was made on a sample of Beaverlodge pregnant solution. In the use of ferrous sulfate for precipitation of vanadium from carbonate leach liquor at 40°C, further tests were made to study the effect of contact time and aeration at different levels of iron concentration, both in synthetic solutions and in Beaverlodge pregnant solution, with and without added vanadium. Experiments were continued on the sodium amalgam reduction of Beaverlodge mill solutions.

Processes are described for the removal of chloride from nitric acid. Work continued on alloying of uranium and iron by direct melting. Three runs of aluminum reductions of U_3O_8 were carried out under cryolite cover. The effect of nitrate addition on moisture content of cast ADU pellets was studied. (W.L.H.)

5096 THE SECOND URANIUM PLANT AT SPRINGFIELDS. R. C. Alexander, L. P. Shortis, and C. J. Turner (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Brit. Nuclear Energy Conf. 5, 264-71(1960) Oct.

The new plant is intended primarily to supply magnox-canned uranium metal fuel elements for civil power reactors and can readily be adapted for production of oxide fuels for advanced types of reactors. The plant can deal with natural or slightly enriched uranium and is capable of producing a wide variety of fuel elements. In the first step for processing ores or concentrates to purified uranyl nitrate the batch-wise ether extractors used in the original plant were superseded by large continuous box extractors using tri-butyl phosphate as solvent. The adoption, in the second stage, of a fluidized-solids technique for the dryway reactions to uranium tetrafluoride has led to substantial savings in capital and operating costs. For the reduction to metal, calcium was replaced by the much cheaper reductant magnesium and the scale of the reaction increased. The scale of vacuum casting of the uranium billet was similarly increased and semi-automatic methods were adopted for heat treatment, machining, and canning of uranium rods. One of the key requirements for making nuclear power competitive in cost with that from fossilized fuel is the improvement in life and reduction in cost of nuclear fuel elements. When substantial progress toward these objectives has been made in the Second Uranium Plant, a sustained effort is necessary for the achievement of further economics in the future. (auth)

5097 THE PROCESSING OF URANIUM ORE CONCENTRATES AND RECYCLE RESIDUES TO PURIFIED URANYL NITRATE SOLUTION AT SPRINGFIELDS. H. Page, L. P. Shortis, and J. A. Dukes (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Brit. Nuclear Energy Conf. 5, 272-84(1960) Oct.

Uranium ore concentrates are dissolved in nitric acid in a multi-stage system. The resulting nitrate solution is filtered on precoat rotary vacuum units and finally purified by a solvent extraction process employing multistage mixer-settler box contactors. A similar integrated process was developed for recycle streams of solid residues arising from the over-all process, so that no uranium bearing residues are now accumulating. The processes are virtually fully continuous and centrally controlled, which reduces labor costs and limits the number of 'contact' workers. The development work on all stages of the process and the considerations which led to the selection of precoat filters and of box contactors for the extraction process are reviewed. Some of the important parameters on which design of the new plant was based are discussed in detail. The plant has now been in operation for some months. Potential improvements for future plants are being pursued. (auth)

5098 THE FLUIDIZED SOLIDS DRYWAY PROCESS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE AT SPRINGFIELDS. E. Hawthorn, L. P. Shortis, and J. E. Lloyd (United Kingdom Atomic Energy Authority, Springfields Works and Risley, Lancs, Eng.). J. Brit. Nuclear Energy Conf. 5, 285-304(1960) Oct.

At present most uranium tetrafluoride is made by the batch operation of dryway furnaces. While the process produces material of admirable quality for subsequent reaction, it has operational and economic disadvantages which make it unattractive to scale up this type of plant. A reappraisal of the chemistry and chemical engineering of the dryway process was carried out. This indicated that savings in raw material could be made by the direct thermal denitration of purified uranyl nitrate to uranium oxide eliminating ammonium diuranate as an intermediate and enabling nitric acid recovery to be effected. No other changes in chemistry looked promising in the time available. The considerations which led to the adoption of the fluidized solid system for the denitration and subsequent dryway reactions and the development and design work leading to the construction of a prototype production plant are reviewed. Ideally, the process should operate continuously, and this is possible, but problems during development and pressing program requirements have led to the initial adoption of batch processing. Development work toward a continuous plant is proceeding. (auth)

Separation Processes

5099 (AAEC/E-50) PULSE COLUMNS IN NUCLEAR FUEL REPROCESSING. PART 1. LITERATURE SURVEY. M. G. Baillie (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). May 1959. Reprinted June 1960. 16p.

A survey of relevant literature on the use of pulse columns for the reprocessing of irradiated nuclear fuel has been made. The effects of design and operating variables on flood point and mass transfer and the various methods of correlation are reviewed. Recommendations are made for further work into some aspects of the design and use of pulse columns. (auth)

5100 (HW-66383) ANION REPLACEMENT REACTIONS FOR THE REMOVAL OF STRONTIUM FROM AQUEOUS SOLUTIONS. L. L. Ames, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 5, 1960. 30p. Contract AT(45-1)-1350. OTS.

The replacement reactions that could be adapted to the removal of strontium from aqueous solutions were investigated. The kinetic anion replacement systems, calcite-phosphate, calcite-fluoride, gypsum-carbonate, and gypsum-phosphate, are discussed along with concomitant Sr^{2+} inclusion into the final product. In a system containing several anions, only a single, least-soluble compound containing the available cation is stable. The replacement reaction rate is directly proportional to the solubility difference between the original solid and final product. Several other variables also affect the reaction rate, including temperature, influent pH, surface area of the initial solid, concentration of extraneous ions, and concentration of active anion. These variables affect diffusion rates to and from reaction sites as well as differences in solubility between initial and final reaction products. The crystal structure of the resulting product greatly affects the concomitant removal rate of Sr^{2+} into the resulting product. (auth)

5101 (JEN-25-DMa/I-1) EL SISTEMA NITRATO DE URANILO-ETER DIETÉLICO-AQUA EXTRACCIÓN DE NITRATO DE URANILO CON AGUA A PARTIR DE DISOLUCIONES ETÉREAS EN COLUMNAS DE PULVERIZACIÓN Y DE RELLENO. (The System Uranyl Nitrate-Dietyl Ether-Water. Extraction by Water in Spray and Packed Columns from Uranyl Nitrate-Ether Solutions). A. Perez Luñia and L. Gutierrez Jodra (Spain. Junta de Energía Nuclear, Madrid). 1960. 32p.

New runs for spray columns and other concentrations in uranyl nitrate for the packed columns are given. New correlations for the over-all H.T.U. are also given. The individual H.T.U. are graphically calculated and show that the film resistances have similar values, being independent of the concentration of the ether phase. The variables studied for the spray and packed colums are: the rate of flow of both phases, the concentration of the initial other phase, and the phase used as continuous. The extraction direction was always from ether to water. The experimental values obtained are compared with those given by other authors for various organic and inorganic systems. (auth)

5102 (NP-9340(Vol. II)(Sect. VII)) CHEMICAL DECANNING AND DISSOLVING OF FUEL ELEMENTS. Å. Hultgren (Aktiebolaget Atomenergi, Stockholm). Section VII of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 93p.

Selective chemical dissolution of fuel cladding offers an attractive alternative to mechanical decladding. Although mechanical processing involves certain advantages such as smaller decanning waste volumes, chemical decanning is simpler and safer to conduct, especially in case of radiation-induced element distortion or rupture. The various fuel types and dissolution processes are discussed in detail. (W.D.M.)

5103 (NP-9340(Vol. III)(Sect. I)) INTRODUCTION TO AQUEOUS REPROCESSING OF URANIUM. Kåre P. Lindland (Norway. Institutt for Atomenergi, Kjeller). Section I of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 34p.

The object of reprocessing is to remove the fission products from the fuel elements and recover fissionable and fertile materials in a form which is suitable for further fabrication into fuel elements. If spent fuel is to be refabricated by direct handling, i.e., without radiation shielding, it is necessary to reduce the concentration of fission products by a factor of 10^5 to 10^8, depending upon the burn-up ratio. Composition of irradiated uranium fuels, methods of separation, principles of solvent extraction of metals, solvent extraction processes, and tail-end treatment and recovery are discussed in detail. (W.D.M.)

5104 (NP-9340(Vol. III)(Sect. II)) AQUEOUS REPROCESSING OF URANIUM BY AMINE EXTRACTION. A. Chesné (France. Commissariat à l'Énergie Atomique, [Paris]). Section II of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 45p.

Continuing development of power reactors has led to new and different fuel elements and materials. These new fuels, containing zirconium, molybdenum, uranium oxide, or stainless steel, and clad with zirconium, Zircaloy, or stainless steel, present new problems in chemical reprocessing. Darex, Sulfex, and Zirflex dissolution processes have been developed, and the products of the Sulfex dissolution in particular, are not amenable to TBP extraction. Also, an extended cooling time is necessary for irradiated fuel before TBP processing can begin. The amine extraction process was thus developed. The general properties of amines are reviewed, and extensive data are presented on the extraction properties of amine sulfates, chlorides, and nitrates for uranium, plutonium, and fission products. Other topics discussed include choice of diluent, the third phase, and re-extraction of plutonium into the aqueous phase. (T.R.H.)

5105 (NP-9340(Vol. III)(Sect. III)) TAIL-END TREATMENT FOR ISOLATION OF Pu. A. Chesné (France. Commissariat à l'Énergie Atomique, [Paris]). Section III of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 37p.

A process is described for final concentration and purification of uranium and plutonium and reduction to a solid form, oxide or metal. For uranium processing evaporation, silica-gel columns and butex extraction are employed. For solidification the Excer and Flurex processes are described. The plutonium tail-end processing involves evaporation, precipitation as hydroxide, TBP solvent extraction, and ion exchange. The solidification of plutonium solution is accomplished by formation of peroxide, followed by precipitation as oxalate or fluoride. The peroxide and oxalate are easily converted to oxide. (T.R.H.)

5106 (NP-9340(Vol. III)(Sect. IV)) CURRENT DEVELOPMENTS IN TBP PROCESSES FOR IRRADIATED FUELS. J. M. Fletcher (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Section IV of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 21p.

There are incentives to improve the TBP processes on economic grounds; first to lower the cost of nuclear power from a particular type of reactor and second, since finality on the best type of reactor is far from being reached, to enable a particular plant to deal with different types of fuels. Various developments, recorded in papers and reports, to improve operating flowsheets, are covered. (W.D.M.)

5107 (NP-9340(Vol. III)(Sect. V)) AQUEOUS REPROCESSING OF THORIUM AND ISOLATION OF U^{233}. J. M. Fletcher (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 16p.

Experience at Harwell and Oak Ridge on the aqueous reprocessing of irradiated thorium is discussed. Both the Harwell and Oak Ridge (Thorex) processes use TBP as the solvent and are based on the usual type of laboratory data for a solvent extraction system. The two types of processes used are reviewed and the particular problem presented by the Pa^{233} half life is discussed in relation to future schemes. (W.D.M.)

5108 (NP-9340(Vol. III)(Sect. VI)) REPROCESSING COSTS. T. J. Barendregt (Norway. Institutt for Atomenergi, Kjeller). Section VI of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 16p.

A nuclear power program can, in principle, be based on two different fuel cycles; either the irradiated material is reprocessed or the fuel, after discharge from the reactor, is stored or buried rather than reprocessed. Under the assumption that investment costs for nuclear plants will decrease by 50%, approximately 2 mills/kwh are left for total recycle cost to be competitive with conventional power plants. Total recycle costs are discussed in terms of burn-up, radiochemical separation, refabrication of fuel, and waste disposal. (W.D.M.)

5109 (NP-9340(Vol. III)(Sect. VII)) FUEL CYCLE COST. Steinar Aas (Norway. Institutt for Atomenergi, Kjeller). Section VII of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 26p.

Fuel cycle costs constitute for present water-cooled power reactors about 30% of the total power costs. The remaining 70% of power costs is discussed briefly. The various steps in the fuel cycle are considered, and the effects

on cost of various fuel-element design variables are reviewed. (W.D.M.)

5110 (NP-9340(Vol. IV)(Sect. I)) NON-AQUEOUS PROCESSING OF SPENT REACTOR FUELS. John H. Schraidt and Richard C. Vogel (Argonne National Lab., Ill.). Section I of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 129p.

Results obtained on the fluoride volatility processes and on pyrometallurgical processes are reported in detail. Although the application of these methods to fuel reprocessing presents some very difficult problems such as operation with molten metal at 1200°C or more, incomplete decontamination, and preparation and handling of PuF_6, the experiences and results to date have been sufficiently encouraging to command extensive interest and continued effort. (W.D.M.)

5111 (NP-9643) SEPARATION OF HEAVY RARE EARTHS BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. (Rozdzielanie Ciężkich Ziem Rzadkich za Pomocą Chromatografii Podziałowej z Odwróconymi Fazami). Report No. 169/V. I. Fidelis and S. Siekierski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Sept. 1960. 9p.

Reversed-phase partition chromatography with TBP as the stationary phase was applied to the separation of heavy rare earths from gadolinium to lutetium. As the eluting agent 11.5, 12.3, and 13.0 M HNO_3 was used. The heaviest rare earths also can be separated with HCl as the eluting agent. The influence of the amount of the rare earth introduced into the column on the shape of the elution curve was investigated. (auth)

5112 (NP-9656) RAZDELENIE ZHELEZA I KOBAL'TA PRI POMOSHCHI ANIONITA ASD-2. (Separation of Iron and Cobalt by Means of Anion Exchanger ASD-2). Report No. 157/OFJ. E. A. Bozhek, I. I. Stronski, and S. Ya. Shimchik (Polish Academy of Sciences. Inst. of Nuclear Research, Krakow). June 1960. 7p.

Isotopes of Fe^{59} and Co^{60} were used in studies of ion exchange separation of small quantities of iron and cobalt by means of strong-base Soviet anion exchanger ASD-2. The separation of Fe^{3+} and Co^{2+} by anion exchanger ASD-2 is identical to that by widely used anion exchanger IX-8. (tr-auth)

5113 (ORNL-3013) POWER REACTOR FUEL PROCESSING PILOT PLANT BROOKHAVEN FUEL PROGRAM. W. T. McDuffee (Oak Ridge National Lab., Tenn.). Dec. 15, 1960. 64p. Contract W-7405-eng-26. OTS.

Results of processing 47 metric tons of Brookhaven spent reactor fuel are summarized. Measured uranium and plutonium losses totaled 1.3 and 0.8% of the fuel processed. Gross γ decontamination factors averaged 9.1×10^4 and 1.2×10^6, respectively, for uranium and plutonium. Improved decontamination from fission products was demonstrated in the operation of the extraction columns with the organic phase as the continuous phase. (auth)

5114 (PG-Report-82) THE APPLICATION OF GAS-LIQUID CHROMATOGRAPHY TO THE ANALYSIS OF CORROSIVE GASES. PART I. DEVELOPMENT OF APPARATUS AND TECHNIQUE FOR THE SEPARATION OF MIXTURES OF CHLORINE TRIFLUORIDE, HYDROGEN FLUORIDE AND URANIUM HEXAFLUORIDE. G. Iveson (United Kingdom Atomic Energy Authority. Production Group. Capenhurst, Ches., England). 1960. 23p. BIS.

Declassified version of IGC-ARDC/P-278.

The behavior of hydrogen fluoride, chlorine trifluoride, and uranium hexafluoride is examined in a gas-liquid chromatography apparatus, using an unreactive column and differential katharometers. The design and construction of the apparatus is fully discussed and the feasibility of the method for the analysis of diffusion plant gas is demonstrated. Discussion of future development work is included. (auth)

5115 (TID-11076) SEPARATION OF YTTRIUM FROM LINDSAY RARE EARTH OXIDES BY LIQUID-LIQUID EXTRACTION. Report No. 90. Period [covered]: May 15, 1957 to July 31, 1957. Justin L. Beeson (Michigan Chemical Corp., St. Louis, Mich.). Aug. 6, 1957. Decl. Feb. 6, 1959. 18p. Project No. 942. OTS.

A process is described for resolving Lindsay rare-earth oxides into three fractions by liquid-liquid extraction, and the results of experiments conducted on an 11-stage York-Scheibel column to accomplish this, are presented. In the separation of light rare earths from a mixture of rare-earth oxides analyzing to be 76% yttrium oxide, 6% of the feed oxides were obtained in the light rare-earth fraction, which analyzed to be 5 to 18% yttrium oxide. The remaining 94% of the oxides appearing in the extract phase analyzed 80.5 to 81.0% yttrium oxide. In the back extraction of yttrium from the extract phase obtained from the light rare-earth separation, nearly all of the oxides were back extracted into the aqueous phase. The oxides in the feed extract analyzed to be about 82% yttrium oxide; the oxides in the back extract analyzed to be 78 to 82% yttrium oxide, and the oxides remaining in the stripped extract analyzed to be 71 to 74% yttrium oxide. (auth)

5116 (TID-11077) RECOVERY OF VERSENE AND WATER FROM RARE EARTH PLANT EFFLUENT. Report No. 109. Period [covered] July 22, 1957 to October 21, 1957. C. R. Jacoby (Michigan Chemical Corp., St. Louis, Mich.). Nov. 4, 1957. Decl. Feb. 6, 1959. 9p. Project No. 942. OTS.

Experimental work was completed on conditions and equipment necessary to recover ammonium versenate from waste copper versenate. Based on an assumed recovery of 570,000 lb/year ammonium versenate with a 95% yield, it is estimated that waste copper versenate can be converted to re-usable ammonium versenate for $0.2417/lb recovered $(NH_4)_3HV$. At a purchase cost of $0.63/lb versene, this represents an annual savings of $221,316 on versene. A preliminary plant cost estimate is $34,666. Based on an assumed recovery of 180,000 lb/year with a 95% yield, it is estimated that the waste can be converted to re-usable ammonium versenate for $0.4427/lb recovered $(NH_4)_3HV$. This represents an annual savings of $33,735 on versene. A preliminary plant cost estimate is $23,700. (auth)

5117 (TID-11079) A STUDY OF THE SEPARATION OF RARE EARTH CONCENTRATE DIGESTION LIQUOR ON THE ION EXCHANGE COLUMNS. Report No. 116. [Period covered] June 18, 1957—July 30, 1957. J. R. Morton (Michigan Chemical Corp., St. Louis, Mich.). Nov. 20, 1957. Decl. Feb. 6, 1959. 4p. Project No. 942. OTS.

Colorado ore concentrate was cracked with hydrochloric acid, the lights removed by double sulfate precipitation, and the ferric iron reduced to the ferrous state with metallic iron. This solution was loaded on the columns and separated with EDTA in the normal manner. The concentration of iron and calcium in the solution was high enough to force most of the rare earths off the column. Of the total material recovered from the columns, 48.3% was rare earths, 11.6% was mainly ferric oxide, and 40.1% was calcium oxide. The rare earths recovered analyzed 27.6% heavies, 43.7% of 95% yttrium oxide, and 28.7% lights. No

99%, 99.9%, or high-purity yttrium oxide was recovered. This method would not be an economical method of separating rare earths as only 20% of the column space would contain yttrium. (auth)

5118 (TID-11080) ION EXCHANGE SEPARATION OF YTTRIUM FROM THE RARE EARTHS USING HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID AS THE ELUTING AGENT. Report No. 133. Period covered: September 21, 1957 to November 29, 1957. J. R. Gump (Michigan Chemical Corp., St. Louis, Mich.). Jan. 23, 1958. Decl. Feb. 6, 1959. 6p. Project No. 942. OTS.

Gross separation of yttrium from the rare earths was found to be possible when ammonium salt solutions of hydroxyethylethylenediaminetriacetic acid (HEDTA) were used as eluting agents through cation exchange resin beds. The transport of the yttrium and rare earth ions, under the conditions used, was 2.5 to 4 times that obtained with elution using ethylenediaminetetraacetic acid (EDTA) solutions. A feed solution prepared from rare earth oxide containing approximately 33% Y_2O_3 can be processed to yield Y_2O_3 with average purity of 77%, with a loss of only 4% of the Y_2O_3 content. A combination of the use of hydroxyethylethylenediaminetriacetate (HEDTA) solutions and ethylenediaminetetraacetate (EDTA) solutions as eluting agents yielded Y_2O_3 of a purity of 99.8% from a short band of Y_2O_3. (auth)

5119 (TID-11081) SEPARATION OF YTTRIUM AND THE RARE EARTHS BY LIQUID-LIQUID EXTRACTION. Report No. 141. Period [covered] September 27, 1957–January 9, 1958. D. A. Lockwood (Michigan Chemical Corp., St. Louis, Mich.). Feb. 28, 1958. 16p. Project No. 942. OTS.

The investigation of Dowsol-12 as an extracting agent for separating yttrium and the rare earths by liquid-liquid extraction has produced 96% yttrium and separation of the heavy rare earths from the lights. This report shows that the monododecyl phosphoric acid, Dowsol-12, can be used successfully in a liquid-liquid extraction process involving separation of yttrium and the rare earths. A number of extractions were presented involving various conditions in five-, seven-, and nine-stage counter-current mixer-settler systems. (auth)

5120 (TID-11089) PILOT PLANT STUDIES ON THE SEPARATION OF YTTRIUM AND THE RARE EARTHS BY CONTINUOUS COUNTER-CURRENT LIQUID-LIQUID EXTRACTION. Progress Report. Report No. 206. Period [covered]: January 30, 1958 to June 6, 1958. James Q. Penrod (Michigan Chemical Corp., St. Louis, Mich.). Dec. 8, 1958. 11p. Project No. 942. OTS.

Pilot plant studies on the separation of yttrium and the rare earths by the use of a continuous counter-current mixer-settler system were initiated using a 21-stage unit made of polyethylene and fabricated by the Udylite Corporation. This unit was designed similar to the mixer-settler then in use at Iowa State College. Designs faults, such as the failure of the unit to contain the weight of liquid required for operation and the failure of the stirrer-pumps to adequately push the aqueous scrub solution through the unit, prevented the successful operation of this unit. However, the information gained in attempting to operate it was invaluable in designing subsequent mixer-settler systems. These later units were made of steel, which was lined with hard rubber and which utilized the air-lift pumps to move the aqueous solution from step to step through the system. Successful operation of a 13-stage and then a second 21-stage pilot-plant continuous counter-current liquid-liquid extractor led to the installation of a 49-stage extraction unit. This report covers the project from the initial start-up of the first polyethylene 21-stage unit to the time of shutdown for further modifications and the installation of the 49-stage unit. Monododecyl phosphoric acid, Dowsol-12, was used successfully as the organic extracting agent for separating yttrium and the rare earths. The organic carrier was originally kerosene, which was later changed to a solution of 3 parts kerosene and 1 part Lorol-22 (n-decanol). The alcohol was added as an anti-emulsifying agent to enable the use of a more alkaline scrub solution. The aqueous scrub consisted of solutions of hydroxyethylethylenediaminetriacetic acid (HEDTA) at various concentrations and acidities. The rare earth feed was originally a 50 g/l chloride solution (pH = 2.0) but was later changed to an acetate solution of varying concentrations and pH levels. The 21-stage extractor was capable of upgrading 85% of the total yttrium from 63% to 85 to 93% purity. Laboratory experiments indicated that this concentrate could be further upgraded to metallurgical grade yttrium (99.0%) by an acid back-extraction. Therefore, the 49-stage unit will be used to separate yttrium and the heavy rare earths from the lights and will have a 21-stage acid back-extractor to separate yttrium from the heavies, followed by a single-stage acid back-extractor to strip the remaining heavies and tetravalent cerium from the organic phase. (auth)

5121 (TID-11090) RECOVERY OF ETHYLENEDIAMINETETRAACETIC ACID AND YTTRIUM FLUORIDE FROM RARE EARTH COLUMN EFFLUENT. Report No. 209. Period [covered]: November 6–30, 1958. D. W. Kase (Michigan Chemical Corp., St. Louis, Mich.). Dec. 22, 1958. 3p. OTS.

A single successful recovery operation has been made using 500 gal of rare earth plant column effluent. Ethylenediaminetetraacetic acid (EDTA) and yttrium fluoride were separately recovered in pure form. The process requires development to be commercial, but the feasibility of such a procedure has been indicated. The recovered ethylenediaminetetraacetic acid was apparently 99.9+% pure, and the YF_3 had an oxygen-argon intensity ratio of 0.32, compared to a tentative maximum allowable ratio of 0.45. (auth)

5122 (TID-11092) REMOVAL OF DYSPROSIUM AND TERBIUM FROM METALLURGICAL GRADE YTTRIUM OXIDE BY LIQUID-LIQUID EXTRACTION. Report No. 224. Period [covered]: July 29, 1958 to September 3, 1958. Patrick A. Lincoln (Michigan Chemical Corp., St. Louis, Mich.). Feb. 20, 1959. 12p. Project No. 942. OTS.

Yttrium oxide containing 99.9% or more of Y_2O_3 and less than 0.1% of total impurities was successfully produced from metallurgical grade yttrium oxide feed by liquid-liquid extraction. The total rare earth impurities ranged between 10 and 780 ppm in the various product batches. The metallurgical grade yttrium fed to the extractor varied from 99.3 to 99.8% Y_2O_3 and contained 1010 to 3325 ppm (0.1 to 0.3%) of rare earth impurities, the balance being silica and calcium. A 49-stage pilot mixer-settler unit was used for the purification. The feed was contacted by an organic solution of kerosene, n-decanol, and monododecylphosphoric acid to extract the yttrium. Hydroxyethylethylenediaminetriacetic acid scrub solution was used to complex the impurities. The high purity product was stripped from the organic phase by 0.4 normal hydrochloric acid in a 21-stage back-extractor. The total amount of metallurgical grade feed used for this experiment was 598.2 lb. The product obtained was 444.2 lb or 74.2% of the feed. In 390.5 lb of this product 99.9% or more Y_2O_3 was contained, based on spectrographic analysis. (auth)

5123 EXTRACTION OF ZIRCONIUM WITH TRI-N-BUTYL PHOSPHATE. R. F. Rolf (Dow Chemical Co., Midland, Mich.). Anal Chem. 33, 149-50(1961) Jan.

The various factors affecting extraction of zirconium by TBP were studied using Zr^{95} tracer in HNO_3 solutions of varying acidity and commercial TBP which was or was not scrubbed with Na_2CO_3 solution. At low acidities (1 to 4 N), a significant decrease in zirconium extraction resulted when scrubbed TBP was used. Scrubbed TBP portions were equilibrated with 6 N HNO_3 for varying periods of time and then used in zirconium extraction. The results indicate that zirconium extraction by TBP is dependent on the concentration of dibutyl phosphate (DHBP), and that the quantity of DHBP formed by acid hydrolysis of TBP increases with the acidity and time of contact. (D.L.C.)

5124 SEPARATIONS BY MEANS OF THE CHROMATOGRAPHIC TECHNIQUE OF DEVELOPMENT BY DISPLACEMENT USING ION EXCHANGE RESINS. Bernard Trémillon (Ecole de Physique et de Chimie, Paris). Bull. soc. chim. France, 1621-9(1958). (In French). (CEA-1177)

After briefly recalling the definitions of chromatographic methods and the general characteristics of the ion exchange phenomenon, the three chromatographic techniques are defined as distinguished by Tiselius: frontal analysis, development by elution, and development by displacement. This last technique, little known and used in spite of its advantages, is analyzed in detail. First of all as shown by Coursier and Huré, it is possible to establish a simplified theory of separation by displacement, assuming an ideal case of which approximate practical examples can be found. It is shown however, by another example, that this simplified theory is often inadequate and needs elaborating especially for the separation of ions with close affinities. It is demonstrated that the experimental results can be explained by the concept of theoretical plates. With these results established, the two means available for improving separations by this technique are analyzed: either to increase the efficiency of the columns by reducing the value of the height of the equivalent theoretical plate by modifying the operating conditions of the columns; or to increase the differences of affinity of the components of the mixture, by superimposing chemical reactions in solution onto the exchange reaction between resin and solution. It will be seen that this way is by far the more efficient and that it opens up immense possibilities for the method. Finally these theoretical principles are illustrated by the few practical applications carried out up to the present: lithium-sodium separation, separation of nitrogen isotopes, separation of amino acids, and finally, the separation of rare earths. This last example shows the extent to which this separation technique can be used in the field of preparative chemistry. (auth)

5125 EXTRACTION OF IRRADIATED URANIUM BY KETONES IN ACID SOLUTION AND IN SOLUTION WITH ACID DEFICIENCY. V. Veselý, H. Beranová, and J. Malý (Inst. for Nuclear Research, Czechoslovak Academy of Science, Prague). Collection Czechoslov. Chem. Communs. 25, 2622-9(1960) Oct. (In German)

The extraction properties of some aliphatic methylalkyl ketones with various lengths and branching of the alkyl chain and of methyl cyclohexanone for irradiated uranium in acid and acid-deficient solutions were followed. The extraction possibilities of the ketones with linear chain are proportional to the concentration of the carbonyl group in the molecule. The decontamination factor of the irradiated uranium in the extraction with aliphatic ketones attains its maximum at a low deficiency of nitric acid, whereas it sinks to a minimum in neutral or in strongly acid-deficient solutions. In strongly acid solutions the decontamination factor is larger than in neutral solutions. (tr-auth)

5126 EXTRACTION OF URANIUM FROM ITS ORES. M. P. Sugier (Centre d'Etudes Nucléaires, [Saclay, France]). Mines et mét. 12p.(1958) Sept. (In French). (CEA-1073)

The chemical extraction of uranium from ores brought research which gave rise to various processing methods. The different methods used at the moment in the chemical processing plants as well as those that can be taken into consideration for future plants are enumerated and briefly described. The processing of ores is composed of 3 principal phases described separately. The different processes that can be used for each phase and the various points which make that process preferred to another one are discussed. (auth)

5127 RECOVERY OF URANIUM AND THORIUM FROM GRAPHITE FUEL ELEMENTS. I. GRIND-LEACH PROCESS. Mildred J. Bradley and Leslie M. Ferris (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 8, 432-6(1960) Nov. (CF-60-1-42).

A grind-leach method for the recovery of uranium from high-density graphite fuel elements containing greater than 5 wt. % uranium was developed on a laboratory scale as a head-end treatment for standard tributyl phosphate solvent extraction processes. With fuel ground to −16 mesh, greater than 99.8% of the uranium can be recovered by leaching twice with boiling 15.8 M nitric acid. Uranium recoveries were lower with less concentrated acid, and with fuel of larger particle size or lower uranium concentration. The grind-leach method is not applicable to fuels containing less than 3% uranium. Leaching −16 + 30 mesh samples of a fuel containing 1.5% uranium and 7.2% thorium with either boiling 15.8 M nitric acid or 15.8 M nitric acid −0.04 M sodium fluoride, resulted in uranium and thorium recoveries of 90 and 86%, respectively. (auth)

5128 THE INFLUENCE OF THE NATURE OF DILUENTS ON THE URANYL NITRATE EXTRACTION BY TBP. M. F. Pushlenkov, E. V. Komarov, and O. N. Shuvalov. Radiokhimiya 2, 537-40(1960). (In Russian)

The influence of polar and nonpolar diluents on uranyl nitrate extraction by tributyl phosphate (TBP) was analyzed. It is shown that the extraction ability of TBP has no single relation to the degree of diluent polarity. The infrared spectra of pure TBP and its solutions in carbon tetrachloride, chloroform, and bromobenzene show various molecular reactions that indicate considerable deviations from ideal behavior. (R.V.J.)

5129 EXTRACTION OF RARE-EARTH FISSION PRODUCTS BY PHOSPHOROORGANIC COMPLEXES. E. N. Patrusheva, N. E. Brezhneva, and G. V. Korpysov. Radiokhimiya 2, 541-8(1960). (In Russian)

The relation between the distribution coefficients of rare earths (Ce, Pm, Eu, Y, and Tm) during diamyl phosphoric acid extraction and the concentrations of nitric acid, hydrogen ions, extracting agent, and nitrate ion was determined, as well as the relation between distribution coefficients and their position on the periodic table. The mechanism of rare earth extraction by diamyl phosphoric acid is described, and the magnitude of the equilibrium constant was evaluated for the formation of the extracted complex. (R.V.J.)

5130 SEPARATION OF Co^{58} FROM NEUTRON IRRADIATED NICKEL BY SOLVENT EXTRACTION. V. I. Levin, M. M. Golutvina, and E. A. Tikhomirova. Radiokhimiya 2, 596-602(1960). (In Russian)

A method of separating cobalt from nickel by tributyl phosphate extraction from hydrochloric acid solution is

described. The method is used for separating carrier-free Co^{58} from irradiated nickel oxide. An analysis was made of Co^{58} purity, and the Co^{60} admixture was determined. (R.V.J.)

5131 SEPARATION OF ASTATINE FROM LEAD, BISMUTH, AND THORIUM IRRADIATED BY 660 Mev PROTONS. B. N. Belyaev, Yung-yi Wang, E. N. Sinotova, L. Nemet, and V. A. Khalkin. Radiokhimiya 2, 603-13 (1960). (In Russian)

A method is suggested for separating chemically pure astatine from lead, bismuth, and thorium irradiated by 660 Mev protons. The method is capable of separating nearly 60% of the astatine. The behavior of astatine during various stages of purification and the causes for losses were analyzed. Production cross sections for various reactions were determined. (R.V.J.)

5132 POSSIBILITY OF ION-EXCHANGE COLUMN STUDIES USING STABILIZED MONTMORILLONITE-H AGGREGATES. R. Platzer and R. Bittel (Centre d'Etudes Nucléaires, Saclay, France). Silicates inds. 24, 550-3 (1959). (In French). (CEA-1384)

The conditions necessary for obtaining stable aggregates of montmorillonite-H, prepared without addition of organic flocculent, is discussed. These aggregates possess the same general ion exchange properties as montmorillonite-H suspensions. Their insolubility and their stable physical form enable them to be used in columns in exactly the same way as the usual organic ion exchangers. The examples of cation fixation and separation described emphasize the similarities between the properties of this exchanger and those of organic cation-exchange resins, and open up possibilities for the extrapolation of the many investigations carried out on organic exchangers to mineral exchangers of this type. Among the essential differences to be noticed, the properties of physical stability and chemical exchange remain the same at temperatures up to 300°C, to a first approximation, under very intense γ irradiation. (auth)

5133 NEW DATA ON RARE-EARTH SEPARATION METHODS. D. I. Ryabchikov and E. A. Terent'eva (Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Uspekhi Khim. 29, 1285-1300(1960) Oct. (In Russian)

Various methods of rare earth separation are reviewed. Fractional crystallization and precipitation, extraction with organic solvents, ion exchange, chromatography, and methods based on ion movability are discussed as well as methods based on the variability of valence states and rates of dehydration. Separation into cerium and yttrium groups simplifies the problem. The cerium subgroup is easily separated by chemical methods; separation of praseodymium and neodymium is more complicated. The yttrium group offers real difficulties, however, complexing (complexion III) followed by precipitation and ion exchange shows good results. 149 references. (R.V.J.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

5134 (CF-60-9-103) ADDITIONAL MISCELLANEOUS MAINTENANCE TOOLS USED IN THE HRT CORE. P. P. Holz (Oak Ridge National Lab., Tenn.). Sept. 26, 1960. 21p. OTS.

A description of several additional miscellaneous HRT core maintenance tools not covered in an earlier report is presented. The function, design, and operation are described for the included items. (See also CF-59-11-123.) (J.R.D.)

5135 (CF-60-10-36) STATUS OF PILOT PLANT SECTION EQUIPMENT DEVELOPMENT PROGRAM. T. S. Mackey (Oak Ridge National Lab., Tenn.). Oct. 14, 1960. 23p. OTS.

A development program is being carried out in the pilot plant to improve the equipment involved in monitoring, metering, and pumping process streams. The equipment under development includes an α monitor, a γ monitor, a waste-water monitor, a liquid flow-rate meter, a canned rotor pump, a diaphragm pump, air lifts, and a pressure-tank pump. (auth)

5136 (DEG-Report-212) INTEGRATION OF THE PRESSURE DISTRIBUTION BETWEEN GAS-LUBRICATED THRUST PLATES. B. Ramsdale and P. J. Stokes (United Kingdom Atomic Energy Authority. Development and Engineering Group, Capenhurst, Ches., England). Mar. 18, 1960. 9p.

The pressure distribution in the thrust region between gas-lubricated thrust bearing plates is approximated. (C.J.G.)

5137 (NP-9612) RESEARCH ON LIQUID METALS AS POWER TRANSMISSION FLUIDS. Progress Report No. 7 [Covering]: Period May 1, 1960—November 1, 1960. R. C. Kumpitsch (General Electric Co. Light Military Electronics Dept., Schenectady, N. Y.). Nov. 1960. 29p. Project No. 8-(1-7331). Contract AF33(616)-5917.

The progress made on the liquid metals program toward proving the feasibility of using the liquid metal NaK-77 as a high-temperature power transmission fluid is reported. Assembly and installation of the test flow loop console in the liquid metals test area was completed, and the high pressure-temperature NaK-77 pump in the liquid metals test area was delivered and installed. Initiation of both the NaK loop console debugging tests and the NaK pump thermal cycling tests is reported, and operational difficulties in both the loop console and the high pressure pump were corrected. Problems encountered in both the thermal cycling and loop debugging tests necessitated changes in the liquid metals program schedule. (auth)

5138 (WADD-TR-59-783) GAS LUBRICATION OF BEARINGS AT VERY HIGH TEMPERATURE. First Summary Report [for] Period March 15, 1959 to December 15, 1959. Fred Macks (Tribo-Netics Labs., Vermilion, Ohio). Jan. 1960. 117p. Project No. 3044. Contract AF33(616)-5982. (AD-237394).

Studies were made of very high-temperature gas lubrication of high-speed bearings. An inert-gas lubricating system, gas-bearing test rig, and gas bearings were fabricated and tested in static conditions at 80 to 1500°F. The lubricating system consists in supplying gaseous nitrogen from bottles through a stainless-steel network of valves, flowmeters, pressure regulators, filters, and heaters. The test rig consists of a gas bearing mounted in a furnace in cantilever fashion supported by two bearings outside the furnace. An evaluation of a clearance-eccentricity measurement method indicated that excessively large temperature-correction factors and erratic results occur at high temperatures. (C.J.G.)

5139 (AERE-Trans-856) ON THE INSTABILITY OF CIRCULAR GAS-LUBRICATED BEARINGS. V. N. Constantinescu. Translated by W. Manz from Acad. rep. popu lare Romîne, Inst. mecan. apl. "Traian Vuia," Studii cercetări mecan. apl. 10, 117-40(1959). 33p.

A theoretical study of instabilities in gas-lubricated

bearings and the factors affecting them is presented. Gas-lubrication equations for a nonstationary system are derived starting with the general pressure equation for gas lubrication. Equations describing the stability of circular bearings are then dealt with. It is shown that stable operation is not generally assured at high and very high speeds. The behavior is somewhat better for dynamic loading (centrifugal) at speeds not too high, for certain values of mass in motion, and for certain relative dimensions of the bearing. The principal cause of instability is compressibility and, more particularly, the formation of low pressure zones in the lubricant layer. (T.R.H.)

5140 THE EFFICIENCY OF FIBROUS AEROSOL FILTERS: DEPOSITION BY DIFFUSION OF PARTICLES OF FINITE DIAMETER. Ralph E. Pasceri and S. K. Friedlander (Johns Hopkins Univ., Baltimore). Can. J. Chem. Eng. 38, 212-13(1960) Dec.

A brief review is given of the derivation of a semitheoretical expression for the filtration efficiency of fibrous aerosol filters operated at low velocities. The correlation is compared with new data taken from the literature and is presented in a simplified form for design calculations. The existence of a minimum filtration efficiency is discussed, and theory and data are compared. (auth)

5141 SOME PROBLEMS IN THE PREPARATION OF QUALITY SPECIFICATIONS. J. M. Wiesen and B. Ostle (Sandia Corp., Albuquerque, N. Mex.). 8p. of "Proceedings of the Fifth National Symposium on Reliability and Quality Control in Electronics, Philadelphia, January 1959. (SCR-65)

Several problems encountered in preparing the quality specifications for procurement of materials are discussed. These include lot description, choice of sampling plan, the advantages of true tests to destruction, sampling of early production, and spot-check sampling. Recommendations for handling each of these problems are given along with examples. (auth)

5142 IMPROVEMENTS IN AND RELATING TO DIAPHRAGM PUMPS. Guy Taite Shoosmith (to Plenty and Son Ltd.). British Patent 845,209. Aug. 17, 1960.

A diaphragm pump is designed for leakproof circulation of fluids as in a nuclear power plant where fluid circuits must be isolated from each other and no leakage can be tolerated. (D.L.C.)

5143 IMPROVEMENTS IN OR RELATING TO POWER PLANT INCLUDING A CLOSED CYCLE GAS TURBINE ENGINE. Raymond Ernest Wigg (to Rolls-Royce Ltd.). British Patent 851,940. Oct. 19, 1960.

A system was invented for charging an accumulator with working gas bled off from the closed cycle of a gas turbine engine comprising an aerodynamic compressor adapted to deliver only a part of its feed gas into the accumulator. The advantage of this system is that contamination of the working gas and the necessity for oil seals are avoided, an important advantage in power plants using reactors as the source of heat. Several configurations of the invention are illustrated. (D.L.C.)

5144 IMPROVEMENTS RELATING TO THE STRESS-RELIEF OF LARGE METAL VESSELS BY ELECTRICAL HEATING. William Leslie Oliver and Kenneth Terry Harrison (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 853,566. Nov. 9, 1960.

A method for relieving stress in a large welded metal structure, such as a reactor pressure vessel which is usually constructed near the reactor site, is presented whereby the required heating to annealing temperature is performed with a hollow column containing electric heating elements inserted into the structure. The column comprises stainless steel sections which serve as a radiant heat reflector for the heating elements and which are cooled by air. The heating elements are of the sheathed wire type, and the means of supporting them in the column is described. (D.L.C.)

5145 IMPROVEMENTS IN OR RELATING TO JOINTS FOR EFFECTING THE SEALING OF THE CONNECTION BETWEEN TWO PIPING ELEMENTS. (to Commissariat à l'Énergie Atomique). British Patent 854,189. Nov. 16, 1960.

A pipe joint is invented for connecting two pipe elements through which a corrosive and/or radioactive liquid flows and comprises a metal ring clamped between the two elements in a recess formed by their flanges which are held together by clamping rings and binding bolts. The inner surface of the ring is formed as a sharp edge and the ring is made out of material softer than the flange material so that a sharp seal at the edge is effected. Complementary sealing rings between the flanges complete the seal, and inspection openings with screw plugs are provided for leakage detection. (D.L.C.)

5146 IMPROVEMENTS IN REMOVABLE CLOSURE MEMBERS FOR PRESSURE VESSELS AND TO A METHOD OF MANUFACTURE THEREOF. Herbert Harris (to Babcock and Wilcox Ltd.). British Patent 854,946. Nov. 23, 1960.

A removable metal closure member for a pressure vessel is designed comprising two flat circular plates spaced from each other and coupled by a ring and a cellular grid construction dividing the space between the plates into cells to accommodate charge tubes. The closure member can be arranged so that a flow of cooling fluid can be established in the space between the plates. Drawings are included. (D.L.C.)

Heat Transfer and Fluid Flow

5147 (AERE-R-3500) PROPAGATION OF THERMAL WAVES THROUGH GRAPHITE WITH UNIFORM COOLING. A. J. E. Foreman and A. R. Curtis (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 12p. BIS.

It is shown that a self-sustaining thermal wave can only propagate through irradiated graphite in the presence of uniform cooling if this is less than some critical value. This result is suggested by an analytic solution of the heat conduction equation for the relaxation time model of the kinetics of the release of stored energy and by numerical computations of the spread of a release of stored energy, using the frequency spectrum (constant activation energy) model for the heat release kinetics. The critical value of the time constant for cooling is estimated to be about 2 hr for typical graphite at 100°C. (auth)

5148 (ANL-6244) ON THE PROBLEM OF LIQUID ENTRAINMENT. Gordon C. K. Yeh and Novak Zuber (Ramo-Wooldridge. Div. of Thompson Ramo Wooldridge Inc., Canoga Park, Calif.). Oct. 1960. 124p. For Argonne National Lab. Contract W-31-109-eng-38, Subcontract W-31-109-38-1159. OTS.

The problem of liquid entrainment by a gas phase is considered with the purpose of gathering, presenting, and correlating available information which may be useful for predicting the liquid carry-over in a boiling water reactor at

high pressure. Correlations which predict water carry-over as a function of pressure, of the height of the vapor dome, and of the vapor mass flow rate are presented and discussed. Because entrainment depends upon the hydrodynamic conditions and upon the expansion of a two-phase bubbling mixture, the transportation of vapor through such mixtures is also discussed. Equations which relate the volumetric vapor fraction to the reduced (superficial) vapor velocity in bubbling at high pressures are presented, and some inconsistencies are noted. Experimental data and correlations which predict the location of the liquid-vapor interface in bubbling at high pressures are also given. Experimental data on water carry-over at high pressures reported in the literature are summarized. The problems of drop formation for bursting bubbles and of drop ballistics are discussed together with some analytical formulations of the entrainment problem. The bibliography may prove useful as a source of additional information on the problems of carry-over, corrosion and on the purity of steam and of water at high pressures. (auth)

5149 (NASA-TN-D-482) AN ANALYSIS OF NUCLEAR-ROCKET NOZZLE COOLING. William H. Robbins, Daniel Bachkin, and Arthur A. Medeiros (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1960. 25p. OTS.

A rocket regenerative-cooling analysis was conducted over a range of reactor power of 46 to 1600 Mw. Although the propellant (hydrogen) is characterized by a large heat-sink capacity, an analysis of the local heat-flux capability of the coolant at the nozzle throat indicated that, for conventional values of system pressure drop and limiting wall temperature, the cooling capability was inadequate. Several techniques for improving the cooling margin were discussed, e.g., high pressure drop, high wall temperature, refractory wall coatings, thin highly conductive walls, and film cooling. (auth)

5150 (OOR-1935.2) FULLY DEVELOPED TURBULENT FLOW IN STRAIGHT RECTANGULAR DUCTS—SECONDARY FLOW, ITS CAUSE AND EFFECT ON THE PRIMARY FLOW (thesis). Technical Report No. 2. Lawrence C. Hoagland (Massachusetts Inst. of Tech., Cambridge). Sept. 1960. 168p. DA Project No. DA599-01-004. Contract DA-19-020-ORD 4538.

The problem of fully developed turbulent flow in rectangular ducts is investigated principally by obtaining experimental measurements of the primary and secondary velocity distributions in ducts with aspect ratios of 1:1, 2:1, and 3:1. Mean primary (axial) velocities are measured with both hot-wire annemometer and pitot-tube instrumentation. Secondary velocities are determined from observations of flow direction using a very sensitive hot-wire system. Secondary flows are found to behave in the manner originally suggested by Prandtl. They are about the same magnitude in all three ducts. Maximum secondary velocities of approximately 1 to 1½% of the axial centerline velocity occur near the wall in the corner region where the large wall shear stress gradient is observed. The secondary flows, by convection of axial momentum, are seen to have a significant effect on the primary flow distribution, particularly by causing the wall shear stress to be nearly uniform around the duct periphery except for the corner region. An evaluation of the axial momentum terms from the experimental measurements shows the secondary convective terms to be important throughout much of the flow. The behavior near the wall of the transverse turbulence intensity components (v' and w') in the presence of a transverse gradient of wall shear is shown to be a major cause of the secondary flow. Expressing these intensity components by a universal relation in the viscous wall region, it is shown that wall shear gradients produce secondary motion driving forces of significant magnitude. Mixture length theories are shown to be inadequate, and the need for measurements of turbulent stresses is discussed. (auth)

5151 (TID-11036) BASIC EXPERIMENTAL STUDIES ON BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report for Month of October 1960. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). 8p. Contract AT(30-3)-187. (MPR-X-10-60). OTS.

The loop was prepared for operation with the first 7-rod test section. Final fabrication and assembly work on this test section was continued. Parts of the second 7-rod test section were redesigned for maximum reliability. (W.L.H.)

5152 (TID-11061) CRITICAL TWO-PHASE, STEAM-WATER FLOWS. H. S. Isbin and H. Fauske (Minnesota. Univ., Minneapolis). Nov. 1960. 34p. Contract AT(11-1)-926. [Sub]contract ANL-SC-109-38-1092. OTS.

Critical two-phase steam-water flows were measured over a range of quality from 0.01 to 1.0, total flows from 500 to 4200 lb/sec-sq ft, pressures from 40 to 360 psia, and pipe diameters of 0.269, 0.125, and 0.5 in. inside diameter. A theory was developed for the two-phase critical flow phenomenon, and extensive comparisons of predicted with experimental values show substantial agreement. (auth)

5153 A PHOTOGRAPHIC STUDY OF POOL BOILING IN THE REGION OF THE CRITICAL HEAT FLUX. Robert Cole (Lewis Research Center, National Aeronautics and Space Administration, Cleveland). A. I. Ch. E. Journal 6, 533-8(1960) Dec.

A photographic study was made to investigate the boiling phenomena in the neighborhood of the critical heat flux. The system consisted of an electrically heated zirconium ribbon, insulated on its underface and suspended in a pool of water at its saturation temperature. Measurements of bubble diameters, bubble positions relative to the heating surface, local bubble frequencies, and contact angles at known time intervals were obtained from the film. Results indicate that at high heat fluxes the primary forces acting on a bubble leaving the surface are the buoyancy and drag forces. A dimensionless relationship is developed relating bubble velocity, bubble diameter, and contact angle at breakoff. Drag coefficients for freely rising vapor bubbles in saturated liquid are found to be representable by the usual drag coefficient-Reynolds number curves for solid bodies. Jakob's plot of bubble frequency as a function of bubble diameter at breakoff is extended to high heat flux values, and a relation proposed by Deissler at the critical heat flux is found to yield reasonable agreement with the experimental data. (auth)

5154 HEAT AND MOMENTUM TRANSPORT CHARACTERISTICS OF NON-NEWTONIAN AQUEOUS THORIUM OXIDE SUSPENSIONS. D. G. Thomas (Oak Ridge National Lab., Tenn.). A. I. Ch. E. Journal 6, 631-9(1960) Dec.

Heat-transfer and pressure-drop measurements were made with non-Newtonian aqueous thorium oxide suspensions. A comparison of the results of the two different kinds of measurement allowed the general features of non-Newtonian thorium oxide suspension heat transfer to be readily identified, thus leading to a clear understanding of anomalies observed in previous suspension heat-transfer studies. Data were obtained at suspension concentrations up to 0.10 volume fraction solids, (1,000 g. of thorium/kg.

of water) in systems having tube diameters of 0.318 and 1.030 in. In addition laminar-flow data were taken with a capillary-tube viscometer with a tube diameter of $\frac{1}{8}$ in. and an L/D of 1,000. It was shown that laminar flow physical properties determined with the $\frac{1}{8}$ in. diameter tube were satisfactory for correlating data taken with tubes up to 1.030 in. in diameter. Until the present study, information was not available which would permit a choice between two different viscosities for use in correlating non-Newtonian turbulent heat transfer and flow data. The limiting viscosity at very high shear rates is shown to give a unique correlation of turbulent data for tube diameters from 0.124 to 1.030 in., whereas the use of the effective viscosity (i.e., the viscosity evaluated at the point value of the wall shear stress corresponding to each given flow condition) gives a pronounced diameter effect in turbulent-flow correlations. The data show that the onset of turbulence for both the pressure-drop and heat-transfer measurements occurs at the same Reynolds number and is approximated by the value predicted by the Hedstrom criterion (II). The heat-transfer transition region extends to Reynolds numbers a factor of four times greater than the critical, as is also the case with Newtonian materials. Heat transfer to thorium oxide slurries in fully developed turbulent flow is the same as that predicted by the usual correlations for Newtonian fluids to within the precision of the experimental data, provided that the Reynolds and Prandtl numbers are calculated with the limiting viscosity at high rates of shear, η, for this viscosity. An approximate form of Martinelli's momentum heat transfer analogy correlates the experimental results within +17 and −36%. (auth)

5155 MIXING IN A JET-STIRRED REACTOR. William Bartok, Carl E. Heath, and Malcolm A. Weiss (Esso Research and Engineering Co., Linden, N. J.). A. I. Ch. E. Journal 6, 686-7(1960) Dec.

Measurements were made of the over-all mixing in a gas-phase flow reactor stirred by the entering feed jets. The mixing was studied by following the decrease in exit concentration after sharp cutoff of a radioactive tracer gas, Kr^{85}. The data showed that over the entire range of average residence times investigated, about 0.4 to 16 sec, the reactor behaved as though 85% of its volume was perfectly stirred and the remaining 15% was in piston flow in series with the stirred region. Relocation of the feed jets would probably increase the fraction of volume that is effectively perfectly stirred to about 95%. (auth)

5156 A NEW TYPE OF THERMAL RADIATOR FOR SPACE VEHICLES. Roger C. Weatherston and William E. Smith (Cornell Aeronautical Lab., Inc., New York). Aero Space Eng. 20, 16-17; 48; 50; 52; 54-5; 57-8(1961) Jan.

A rotating belt radiator operating on a heat capacity principle is described. Meteoroid impacts and high inertial loads would not affect it. Each belt element is designed so that it is heated by the waste heat from the power plant and then follows a closed trajectory through space until it is cooled to some designated temperature. At power levels in the Mw range, the belt radiator would weigh only 15 to 25% of a conventional tube-and-heater radiator. A number of variations in the design are discussed. Other types of space radiators are described and compared with the belt radiator. (M.C.G.)

5157 INVESTIGATION OF NATURAL CONVECTION HEAT TRANSFER IN LIQUID SODIUM. John S. McDonald (Atomics International, Canoga Park, Calif.) and T. J. Connolly. Nuclear Sci. and Eng. 8, 369-77(1960) Nov.

An experiment was performed to investigate the transfer of thermal energy by natural convection from molten sodium to a cold plate. A large tank of sodium was used to simulate a semi-infinite mass of sodium. A horizontal circular plate in intimate contact with the sodium surface was cooled by flowing tetralin which caused its temperature to be lower than the sodium bulk temperature. As a result, natural convection occurred in the sodium and thermal energy was transferred from the sodium to the plate. Data were collected at steady-state conditions for values of the Rayleigh number from 4.8×10^6 to 4×10^7. It was found that the experimental results could be correlated by the expression $Nu = 0.0785\ Ra^{0.32}$, where Nu is the Nusselt number, and Ra is the Rayleigh number. The calculated probable error in the Nusselt number given by this equation is 1.08, and the multiple correlation coefficient for the experimental results and the equation is 0.954. This result is shown to be consistent with the results of other investigators who used different fluids in physical systems somewhat similar to that used in this experiment with sodium. (auth)

5158 FLUID FLOW THROUGH A POROUS CHANNEL. W. E. Wageman and F. A. Guevara (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids 3, 878-81(1960) Nov.-Dec.

Approximate solutions of the equations of motions governing laminar incompressible fluid flow through a cylindrical channel with a porous wall are derived. The invalidity of an approximation in the solution of these equations under certain circumstances is pointed out, and the results of a numerical integration in the region where the approximation is invalid are indicated. A brief description is given of an experiment to verify the calculations, and some interesting results are noted. (auth)

5159 THEORY OF GAS BUBBLE DYNAMICS IN OSCILLATING PRESSURE FIELDS. Milton S. Plesset and Din-Yu Hsieh (California Inst. of Tech., Pasadena). Phys. Fluids 3, 882-92(1960) Nov.-Dec.

The behavior of a permanent gas bubble in a liquid with an oscillating pressure field is analyzed with a linearized theory. If the assumption is made that conditions within the bubble are uniform, the thermodynamic relations found are as expected; i.e., at low frequencies the bubble behaves isothermally and at high frequencies the behavior becomes adiabatic. A more detailed analysis, which allows the bubble interior to vary not only in time but also in space, leads to an average isothermal behavior for the bubble even in the high-frequency limit. (auth)

Instrumentation

5160 (AD-241204) DEVELOPMENT OF A TACTICAL GAMMA NEUTRON DOSIMETER. Final Report. I. A. Berstein, R. C. Fix, J. E. Mayer, Jr., and P. F. Russo (Controls for Radiation, Inc., Cambridge, Mass.). June 24, 1960. 13p. Contracts DA-18-108-405-CML-198 and DA 18-108-CML-6495.

The design and performance are described for automatic equipment to fill and seal E-5 chemical γ-neutron radiation dosimeters. The various auxiliary equipment systems were also assembled and tested. (C.H.)

5161 (AERE-M-771) A LOW ENERGY BETA PROBE. K. E. G. Perry and R. A. Bishop (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 15p. BIS.

A probe (A.E.R.E. type 1667) was designed for the detection and measurement of low-energy β radiation. The

probe has an efficiency of 14% for C^{14} and 28% for Sr^{90}. The detecting area is over a 5-in.-diam. circle and the design is suitable for use with most standard ratemeters. (auth)

5162 (AERE-NM/95) NOTE ON THE CHARACTERISTICS OF MAGNETIC RECORDING HEADS AND TAPE. D. A. Boyce and G. C. Cox (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1959. 14p.

Measurements made on a modified Wright and Weaire tape deck type 2C and on A.E.R.E. Magnetic Recording Equipment type 1534A are described. The equipment was designed for the analog recording of nuclear pulses and the tape decks have been fitted with Epsylon record/replay multi-track heads. Measurements were made to determine the tape resolution, linearity, crosstalk, and delay between coincident pulses recorded on adjacent tracks. Investigations carried out on tape with a Mylar backing indicate that resolutions of better than 2.0% can be obtained with both equipments. (auth)

5163 (HW-65334) INTEGRATED RADIOLOGICAL INSTRUMENTATION SYSTEM PLANNING. W. G. Spear (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 14, 1960. 39p. Contract AT(45-1)-1350. OTS.

A basic information analysis is presented on in-use plant radiological instrumentation, instrumentation now undergoing active development, and future development work being contemplated; the analysis will serve as a possible guide to long-range orientation of development work on radiological instrumentation. The analysis covers such items as hands-and-shoes monitors, film badges, general survey instruments, air monitors, data transmission, and alarms. The advantages of standardization of monitoring units are discussed. (D.L.C.)

5164 (LAMS-2455(p.98-104)) HUMCO II: A NEW 4π LIQUID SCINTILLATION COUNTER. E. C. Anderson, R. L. Schuch, and V. N. Kerr (Los Alamos Scientific Lab., N. Mex.).

Design modifications are described for a 4π liquid scintillation counter for use in whole-body radiation measurements on humans. (C.H.)

5165 (LAMS-2455(p.105-12)) THE LOS ALAMOS SMALL-ANIMAL COUNTER III (LASAC III). R. L. Schuch (Los Alamos Scientific Lab., N. Mex.).

The design and construction are described of a whole-body liquid scintillation detector for small animals. The well-type detector permits low-level measurements of a wide range of gamma-emitting isotopes with counting efficiencies to 60 per cent. (C.H.)

5166 (LAMS-2455(p.118-22)) RADIATION DOSE RATES ABOVE THE ATMOSPHERE. M. A. Van Dilla, M. W. Rowe, R. D. Hiebert, and J. A. Sayeg (Los Alamos Scientific Lab., N. Mex.).

The development and calibration of tissue-equivalent ion chambers for measurements of radiation dose rates above the atmosphere are reported. (C.H.)

5167 (LAMS-2455(p.123-6)) MOONSPEC: MEASUREMENT OF RADIOACTIVITY OF THE LUNAR SURFACE. M. A. Van Dilla and E. C. Anderson (Los Alamos Scientific Lab., N. Mex.).

Equipment and procedures are described which will be used in measurements of radioactivity on the surface of the moon. (C.H.)

5168 (LAMS-2455(p.129-33)) CHEMICAL SYSTEMS FOR LIQUID SCINTILLATION DOSIMETRY. D. L. Williams and F. N. Hayes (Los Alamos Scientific Lab., N. Mex.).

Progress is reported in an investigation of chemical systems for use in liquid scintillation radiation dosimeters for simultaneous gamma and fast neutron dose rate measurements. Neither mineral oil/9,10-diphenyl-anthracene nor gadolinium-loaded p-xylene solution showed enough promise to warrant further study. (C.H.)

5169 (LAMS-2455(p.134-7)) PHOTODETECTORS FOR SCINTILLATION DOSIMETRY IN THE FIELD. D. L. Williams and F. N. Hayes (Los Alamos Scientific Lab., N. Mex.).

A dose rate device was designed and constructed which can be used to monitor gamma dose rates in the field over a range of 1 mr/hr to several hundred r/min. (C.H.)

5170 (LAMS-2455(p.189-94)) ADVANCES IN THE THRESHOLD DETECTOR TECHNIQUE OF MEASURING NEUTRON FLUX, SPECTRA, AND TISSUE DOSE. J. A. Sayeg (Los Alamos Scientific Lab., N. Mex.).

Good agreement was obtained between film track and threshold detector methods of measuring neutron flux, spectra, and tissue dose. The equivalent foil method of calibration and the best fit values for fast neutron cross sections and the first collision dose values were used in the computations. (C.H.)

5171 (NAA-SR-Memo-5385) FREQUENCY CONVERTER EVALUATION. J. W. Crowe and B. G. Seeley (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 15, 1960. 74p. Project: Snap II. OTS.

Various methods of frequency conversion of electric power within the range dc to 3.2 kc are evaluated with respect to weight, efficiency, and reliability. AC systems in general were found to rate approximately 25 to 100 watts per pound and 50% efficient. DC systems were found to rate about 250 watts per pound and 80% efficient. (C.J.G.)

5172 (NP-9628) PHOTON MONOCHROMATORS. J. Goldemberg and A. O. Hanson (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisícas). 1960. 33p. (Notas de Física Vol. VI, No. 9).

In most cases there are no sharp resonances in the giant resonance region, and it would be useful to have some way of studying the photonuclear reactions with photons having a well-defined energy. Three methods that have been used for obtaining monoenergetic photons are discussed. The monochromator scheme, which is in operation at the University of Illinois with the 22-Mev betatron, is discussed in some detail. (W.D.M.)

5173 (NP-9636) A SOLID-STATE LOGARITHMIC VIDEO AMPLIFIER. Technical Report No. 1604-1. G. S. Bahrs and W. D. Hindson (Stanford Univ., Calif. Solid-State Electronics Lab.). Apr. 22, 1960. 37p. Contract DA36(039)SC-78296.

An all solid-state logarithmic video amplifier that develops output pulse amplitude proportional to the logarithm of the input pulse amplitude is described. The resultant compression reduces the ratio of maximum to minimum signal amplitude from 3,000:1 at the input to 10:1 at the output, thus allowing the pulses to be viewed on an oscilloscope or recorded on magnetic tape. Conversion accuracy is such that from observations of the output pulses, the amplitude of any signal within the 70 db input range may be estimated to within 3 db. (auth)

5174 (NP-9648) EFFECTS OF VARIATION IN THE AMBIENT AIR ON THE CALIBRATION AND USE OF IONIZATION DOSEMETERS. G. P. Barnard, G. H. Aston, and A. R. S. Marsh (Gt. Brit. National Physical Lab., Teddington, Middx., England). 1960. 32p.

The effects of variations in ambient air on absolute measurements of roentgens by cavity ionization chambers are examined. (J.R.D.)

5175 (NP-9651) WIDE RANGE TACTICAL MONITORING INSTRUMENT IM-145 (XE-1)/UD. Quarterly Progress Report No. 1 [for Period] July 15, 1960–October 15, 1960. E. J. Dilanni and F. C. Riggin (Nuclear Corp. of America. Instrument and Research Div., Denville, N. J.). 47p. DA Project No. 3D22-09-001-03. Contract DA-36-039 SC-84932.

Progress is reported in an engineering study to develop a wide range tactical monitoring instrument to operate in the 0.01 mr/hr to 500 r/hr range. The instrument utilizes two Geiger tubes and circuitry for complete coverage of γ radiation intensities in the range specified and β detection capabilities sufficiently sensitive for reading the ten-day maximum permissible limit of mixed fission products in drinking water. Major design features are described. (C.H.)

5176 (SC-4461(RR)) DESIGN AND CONSTRUCTION OF A UNIT FOR MEASURING METAL SKIN TEMPERATURES. PHASE I, THEORETICAL ANALYSIS AND DESIGN. [Period covered]: February 1956 through April 1956. (Detroit Controls Corp., Redwood City, Calif.). Dec. 1960. 49p. For Sandia Corp. OTS.

A program was undertaken to develop a special unit for measuring the temperature variations at various given depths in a metal skin. The results of the initial phase of the work, which was devoted to an investigation of the requirements of such a unit and formulation of promising designs for meeting these requirements, are described. A review of possible heating conditions indicated that for a representative case (gas temperature = 1000°F, h = 1000 Btu/hr-ft^2-°F) the maximum temperature difference over the allowable depth variation of ±0.003 in. would be approximately 10 to 20°F in a 0.125-in.-thick steel skin. Various designs in which the sensing element would be located within this depth tolerance were studied. The most promising design was suggested for initial laboratory investigation during Phase II of the program. (auth)

5177 (SCDR-141-60) ACCESSORY FOR AC MEASUREMENTS. L. B. Converse (Sandia Corp. Livermore Lab., Livermore, Calif.). Aug. 1960. 4p. OTS.

A modified slide-back voltmeter is described for use in measuring sine-wave voltages. The device directly compares a d-c level to a peak voltage and reports the measurements in either peak or rms values. (C.J.G.)

5178 (TID-6922) PROPOSAL FOR A NEW TYPE OF PHASE-MEASURING SYSTEM HAVING AN OUTPUT VOLTAGE PROPORTIONAL TO PHASESHIFT. Microwave Memo No. 4. Mark A. Heald ([Princeton Univ., N. J.]). July 6, 1959. 5p. OTS.

A phase-measuring system having an output voltage proportional to the phase shift is described. The system employs a frequency-modulated oscillator and dispersive bridge. The interference signal appearing at the detector has its principal Fourier component at the harmonic of the modulation frequency nearest to N, the number of bands that would appear in the Gardner-Wharton raster display. A phase shift in one arm of the bridge produces a phase modulation of this component. This phase modulation is recovered by feeding the output signal to a tuned amplifier, passing only this one harmonic, followed by a limiter-discriminator-integrator chain. High-frequency response is limited by the carrier-frequency aspect of the modulation frequency. Low frequency is set by the integration time-constant. (C.J.G.)

5179 (TID-11242) THE CONSTRUCTION OF A SENSITIVE DIFFERENTIAL MANOMETER FOR THE MEASUREMENT OF THE VAPOR PRESSURE OF SOLUTIONS OF ELECTROLYTES IN AMINE SOLVENTS. M. Louis Arin and Frederic C. Schmidt (Indiana Univ. Foundation Research Div., Bloomington). [nd]. 7p. Contract [AT(11-1)-256]. OTS.

In the study of the physical chemistry of solutions of electrolytes in amine solvents, it is necessary to make vapor pressure measurement for the purpose of determining the ion pair association that is connected with the activities of these ions. The purpose of the research was to measure vapor pressures of solutions in the dilute region of 10^{-1} to 10^{-3} molal. For such research a sensitive vapor pressure apparatus was designed. It is calibrated and is in operation at 25.000 ± 0.002°C. (W.L.H.)

5180 (TID-11269) A TRANSISTORIZED HIGH INPUT IMPEDANCE AMPLIFIER (thesis). Daniel M. Reed (Kansas. Univ., Lawrence). Dec. 1960. 62p. OTS.

The design of an amplifier for coupling a piezoelectric transducer to a cathode-ray oscilloscope is described. The design can be used in the construction of practical transistorized high-input impedence amplifiers. (J.R.D.)

5181 (AEC-tr-4378) STUDIES ON ORGANIC MICROANALYSIS (EIGHTEENTH REPORT). BASIC ACTION OF CLAUSON-KAAS' MICROHYDROGENATING APPARATUS FOR VOLUMETRIC ANALYSIS. Keiichiro Hozumi. Translated from Yakugaku Zasshi 79, 131-5(1959). 12p. JCL.

The design and operation of the Clauson-Kaas type microhydrogenating apparatus are described. (J.R.D.)

5182 (AEC-tr-4379) STUDIES ON ORGANIC MICROANALYSIS (NINETEENTH REPORT). MODIFICATION OF THE MICROHYDROGENATING APPARATUS FOR VOLUMETRIC ANALYSIS AND ITS RAPID CALCULATION METHOD. Keiichiro Hozumi. Translated from Yakugaku Zasshi 79, 135-9(1959). 12p. JCL.

An improved microhydrogenating apparatus is described in which the stability of action is much better than was found in earlier models. Rinsing and drying were simplified, adding to the convenience of exchanging solvents as demanded by certain samples. (J.R.D.)

5183 BUBBLE CHAMBERS. Hugh Bradner (Univ. of California, Berkeley). Ann. Rev. Nuclear Sci. 10, 109-60 (1960). (UCRL-9199)

A survey is given of literature pertaining to bubble chambers. The survey (a) indicates the great importance of bubble chambers and reviews the theory of their operation, (b) discusses chamber designs and data handling techniques, and (c) assembles information that may be of use in planning experiments. Emphasis in the latter sections is placed on large bubble chambers, especially on large hydrogen bubble chambers. A comparison is made of the characteristics of the bubble chamber to those of other types of nuclear particle detectors. 84 references. (B.O.G.)

5184 MECHANICS AND ELECTRONICS AS AUXILIARY TECHNIQUES IN NUCLEAR RESEARCH AND EXPLOITATION. J. Weill (Centre d'Etudes Nucléaires, Saclay, France). Bull. soc. franç. mecaniciens No. 25, 9-16(1957). (In French). (CEA-1279)

Electronics and mechanics form the basic techniques used in the field of measurement and control in nuclear physics experiments and in nuclear machine installations. Some instruments typical of the use of these techniques in the fields of calculation, detection, amplification, and nuclear installations are described. (auth)

5185 THE CANADIAN STANDARD FREE-AIR CHAMBER FOR MEDIUM QUALITY X-RAYS. W. H. Henry and G. Garrett (National Research Council, Ottawa). Can. J. Phys. 38, 1677-89(1960) Dec. (NRC-6031)

A description is given of the Canadian standard free-air chamber for measurement of medium quality x rays, including measurements of the contribution from radiation scattered from the air and from the diaphragm. A method is given for the accurate alignment of the chamber and x-ray source. (auth)

5186 COLLECTION TIME OF THE LIGHT OF A CHERENKOV DETECTOR WITH SCATTERING WALLS. Jean-Pierre Patry, Jacques Seguinot, and Maurice Scherer (Faculty of Sciences, Caen, France). Compt. rend. 251, 2012-14(1960) Nov. 7. (In French)

The theoretical study of the nondirective Cherenkov detector with respect to the effect of the optical properties of their walls was made by Mando (Nuovo cimento 12, No. 1 (1954)). The problem was studied experimentally and the properties of a Cherenkov detector with reflecting walls were determined. The present work has the purpose of comparing its light collection time with that of the same detector provided with scattering walls. (tr-auth)

5187 "MACHINE TIME" IN TIME AMPLITUDE CONVERSION. E. Gatti (Centro Informazioni Studi Esperienze, Milan and Istituto di Fisica del Politecnico, Milan) and V. Svelto. Energia nucleare (Milan) 7, 736-7(1960) Oct. (In English)

The most diffused method of time to amplitude conversion for time interval measurement is by current integration on a capacitor. The "machine time" is coincident with the centroid of the used fraction of the input current pulse. (M.C.G.)

5188 A HIGH SENSITIVITY SEMICONDUCTOR DIODE MODULATOR FOR DC CURRENT MEASUREMENT. Harold E. De Bolt (Avco Research and Advanced Development Div., Wilmington, Mass.). IRE Trans. Nuclear Sci. NS-7, No. 4, 1-4(1960) Dec.

A semiconductor diode modulator capable of measuring d-c currents down to 10^{-10} to 10^{-11} amp is described. This modulator utilizes one diode although a second is normally installed for balance purposes in high-sensitivity measurements. The modulator utilizes pulse techniques instead of sine waves which make possible the high sensitivity. The circuit details of the modulator and design criteria are discussed. (auth)

5189 DUAL PHOSPHOR DETECTORS. R. Monaghan and B. F. Wilson (Well Surveys, Inc., Tulsa, Okla.). IRE Trans. Nuclear Sci. NS-7, No. 4, 32-5(1960) Dec.

A technique is described using two scintillation phosphors with different decay times mounted on a single photomultiplier tube. The scintillations from the two phosphors are then separated in a pulse length discrimination circuit. The dual phosphor detector is compact and is suitable for use in survey meters and well-logging instruments to record different types of radiation simultaneously. (auth)

5190 ENERGY RESOLUTION CORRECTION FOR SCINTILLATION SPECTROMETERS. Leonard B. Gardner (Litton Industries, Woodland Hills, Calif.). IRE Trans. Nuclear Sci. NS-7, No. 4, 36-44(1960) Dec.

A computational scheme is presented for correcting the energy resolution of scintillation spectrometers. This scheme pertains only to experimental data and does not rely on theoretical considerations of energy absorption within the scintillator. Applications to beta spectroscopy and analysis are included, and a derivation of the ideal scintillation line and the various factors which in practice statistically modify the ideal shape is given. (auth)

5191 THE A.C. OPERATION OF ION CHAMBERS AT HIGH FLUXES. J. Watson (Ericsson Telephones Ltd., [London]). J. Brit. Nuclear Energy Conf. 5, 240-9(1960) Oct.

When a sinusoidally varying potential difference is applied between the electrodes of an ion chamber subject to ionizing radiations, the motion of the charge carriers and the form of the current in the external circuit depend upon the applied voltage and frequency, the gas filling and the flux level. A brief analysis of such conditions is made with space-charge effects neglected, and is then modified semi-empirically to take account of space-charge phenomena. In the course of this analysis, a definition of 'saturation' as applied to chambers using alternating polarizing voltages is proposed, and a series of experiments is described showing how variations in the parameters affect this condition. Throughout the tests a standard A.E.R.E. RCl ion chamber was used and was irradiated in the reactors 'Gleep' and 'Bepo'. (auth)

5192 USE OF A LIQUID SCINTILLATOR COUNTER FOR BETA PARTICLES. T. B. Ryves (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Brit. Nuclear Energy Conf. 5, 250-1(1960) Oct.

A simple counting technique is described for absolute counting of β particles using a 4π liquid scintillator counter technique. The radioactive sample is deposited on a thin backing film of transparent material, which is then immersed in the liquid scintillator. It was found that for samples with a maximum β particle energy greater than 0.7 Mev the detection efficiency was close to 100%, comparing favorably with other methods of absolute counting. (auth)

5193 LENS MASS-SPECTROMETER LEAK DETECTOR. D. Cossutta and W. Steckelmacher (Edwards High Vacuum Ltd., Crawley, Sussex, Eng.). J. Sci. Instr. 37, 404-10(1960) Nov.

A new mass-spectrometer leak detector based on the use of an iron-shrouded axially symmetrical magnetic lens for focusing ions in the low mass range was investigated. By taking precautions to keep the hydrogen background at a low and stable level (by the use of a mercury-vapor pump, liquid-air traps, and clean construction) it was possible to use hydrogen as a search gas. Leaks of 5×10^{-10} torr liter/sec corresponding to an indication of a change in ion current reading of about 3×10^{-12} amp (for hydrogen) were consistently detected with an almost instantaneous response when testing equipment of a few liters volume using either hydrogen or helium as search gas. Some measurements of the mass spectrum obtained with this instrument are given. A very reliable and convenient version of a compressed-powder leak is also described. (auth)

5194 SWEPT LANGMUIR PROBE SYSTEM FOR INTENSE GAS DISCHARGES. H. W. Jones and P. A. H. Saunders (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Sci. Instr. 37, 457-9(1960) Dec.

An apparatus is described which provides a pulse of

biasing voltage to a probe system so that electron temperatures up to 2×10^{5}°K and ion densities up to 5×10^{14}/cc can be measured. The system consists of a low impedance voltage sweep generator, a transformer-coupled measuring circuit, and a logarithmic amplifier. The apparatus can be used to sample a portion or the whole of the electron energy distribution by using double probes of equal or greatly unequal areas. The probe plots would be displayed directly on an oscilloscope. (auth)

5195 PHOTOMULTIPLIER SOFT X-RAY SPECTROMETER. L. Jacob, R. Noble, and H. Yee (Univ. of Liverpool). J. Sci. Instr. 37, 460-3(1960) Dec.

A description is given of a soft x-ray spectrometer which uses a Be–Cu photomultiplier as a detector. Unlike most spectrometers of this type, it is not a modification of a previously existing photographic instrument, but was designed specifically to take advantage of the new technique. In particular, the photo-detector is made to move around the Rowland circle by the simple expedient of mounting it on a radial arm. Its method of use is described, and the emission band spectra of Al, Mg, Na, and Li are given as examples of results obtained with it. (auth)

5196 MONITOR FOR THE QUANTITATIVE DETERMINATION OF BERYLLIUM IN THE ATMOSPHERE. M. S. W. Webb, R. J. Webb, and P. C. Wildy (United Kingdom Atomic Energy Authority, Woolwich Outstation, Eng.). J. Sci. Instr. 37, 466-71(1960) Dec. (AERE-R-3318)

Air was drawn through a triggered intermittent arc and the intensity of the beryllium doublet at 3130 A was monitored, together with the adjacent background; and the ratio of these intensities was recorded on a ratio recorder. Provision was made for frequent calibration by means of an aerosol of known concentration, produced by an auxiliary spark between beryllium-copper electrodes. The accuracy and sensitivity of the instrument are not materially affected by the chemical form of the beryllium and are unaffected by the sizes of particles normally encountered in atmospheric dust. The instrument is mobile, fully automatic, and rapid in operation, one result being produced each minute. The limit of detection is 1 $\mu g/m^3$ for a 20-sec sampling time. The instrument is considered to have potentialities for the determination of other elements in air, apart from beryllium. (auth)

5197 GEIGER COUNTER BACKGROUNDS. B. L. Cohen (Oak Ridge National Lab., Tenn. and Univ. of Pittsburgh). J. Sci. Instr. 37, 475-8(1960) Dec.

An extensive study of counting backgrounds in ten essentially identical Geiger counters is reported. Important long-term time variations were found; their rate was generally less than ½% per day; they changed direction frequently, and their total magnitude averaged about 6%. They could not be correlated with counter efficiency and were not, in general, correlated among the different counters. Consecutive day differences were generally less than 1% although about 20% of the time there were nonstatistical variations in the same direction in all counters, averaging 2.3% in magnitude. No day-night variations were detected within an accuracy of one part in 300. Temperature effects were found to be extremely important. An experience with an area-wide air contamination is discussed. (auth)

5198 PROTECTIVE DEVICE FOR STANDARDIZATION OF FILMS FOR γ RADIATION DOSIMETRY. Valerija Paic (Univ., Zagreb and Ruder Boskovic Inst., Zagreb). Phys. in Med. Biol. 5, 119-29(1960) Oct. (In French)

A device for the calibration of films exposed to γ radiation from a source of 20 mg of radium is described, which protects the operator from the direct radiation of the source. Parts of the films are covered with filters of cadmium, tin or aluminum 1 mm thick. Correction factors are given to establish the usual calibration curves. It was found that the establishment of the calibration curve for the part of the film under cadmium or tin is possible without applying correction factors. (auth)

5199 RESISTIVITY MONITOR TO INDICATE OXIDE CONTENT OF SODIUM. L. R. Blake (Dounreay Experimental Reactor Establishment, Caithness, Scotland). Proc. Inst. Elec. Engrs. (London), Pt. A, 107, 383-94(1960) Aug.

The electric resistivity of sodium or sodium-potassium is continuously measured while flowing at operating temperature in a pipe to provide an indication of impurity level, particularly of oxygen. The meter is designed to be sensitive to a change of one part in 10^6 in oxygen level, corresponding to a change in resistivity of about one part in 10^4. Two types of resistivity meters are described, both of which have been installed in the Dounreay Fast Reactor. (auth)

5200 USE OF SILICON p-n JUNCTION DETECTORS IN STUDIES OF NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Almon E. Larsh, Glen E. Gordon, and Torbjørn Sikkeland (Univ. of California, Berkeley). Rev. Sci. Instr. 31, 1114-18(1960) Oct. (UCRL-9240)

Experiments in which silicon p-n junctions were used as detectors of fission fragments and elastically scattered heavy ions are described. The curve of pulse height vs. energy for carbon particles is linear and passes through the origin. Points for Cf^{252} fission fragments and α particles fall on the curve determined by the carbon-particle points. This result implies that the energy required for electron-hole pair formation is the same for the three types of particles. No "ionization defect" is observed for the fission fragments. Some other possible uses for the detectors of this type are suggested. (auth)

5201 RECENT DEVELOPMENTS IN GAMMA RAY DOSIMETRY. S. I. Taimuty (Stanford Research Inst., Menlo Park, Calif.). p.9-17 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

A review of recent developments and an assessment of the present status of γ-ray dosimetry are given. Among the recent developments discussed are experimental evaluations of a large number of integrating (total dose) dosimeters; improvements in the ceric sulfate and anthracene (luminescence degradation) dosimeters; new plastic, glass, and luminescence dosimeters; and recent developments in dose-rate measurements with ionization chambers, calorimetry, and semiconductor radiation detectors. In summary, good liquid dosimeters are available for total dose measurements in the range 10^4 to 10^8 rads, and usable solid dosimeters exist for the range 10^4 to 5×10^9 rads. However, better solid dosimeters are still needed. In addition, satisfactory ionization methods are available for high dose-rate measurements, and a recently announced graphite sphere calorimeter shows considerable promise as a primary standard for absorbed dose measurements. (auth)

5202 REACTOR MONITORING BY CALORIMETRY. K. Lynn Hall, Rudolf F. Klaver, James G. Carroll, and

Robert O. Bolt (California Research Corp., Richmond). p.30-9 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Experience with monitoring mixed radiation fields in nuclear reactors is described. Dose rates were measured by the radiation-produced heat in simple calorimeters constructed for this purpose. Principles of construction are reviewed for two types of instruments. Accuracies of about 10 per cent are estimated. One type of calorimeter measured the total reactor radiation. This device embodied a graphite radiation absorber suspended within a hollow cylinder. Heat flowed radially to the wall of the cylinder. Four units of this type were operated in the Materials Testing Reactor. The other type of instrument measured only the γ portion of the reactor radiation. Neutron sensitivity was minimized by using lead as the absorber. Heat flowed axially along the lead rod to a heat sink. Three versions were built in evolving the final model which was used to determine γ heat in the Brookhaven graphite reactor. (auth)

5203 IMPROVEMENTS IN OR RELATING TO THERMOCOUPLE ARRANGEMENTS. Alan Gordon McGregor and Maurice Hale (to United Kingdom Atomic Energy Authority). British Patent 852,782. Nov. 2, 1960.

A thermocouple arrangement for measuring the temperature of a body inside a vessel by access through a hole is designed so that, upon evacuating the vessel, the thermocouple is advanced automatically into the vessel to contact the body. The arrangement comprises a pressure-sensitive flexible sealing member, usually a bellows, adapted to seal the hole and a thermocouple attached to the bellows. When the vacuum inside the vessel is released, the thermocouple returns to its original position. This arrangement should be useful with vacuum apparatus such as in the melting and casting of reactive metals. (D.L.C.)

5204 IMPROVEMENTS IN OR RELATING TO GEIGER-MÜLLER COUNTING TUBES. (to Philips Electrical Industries Ltd.). British Patent 854,372. Nov. 16, 1960.

Four Geiger-Mueller counting tube designs filled with a gaseous mixture containing at least 0.001 per cent halogen are described in which the space comprises two joined parts of different volume, the smaller part containing the cathode and anode. In one design, the wall in the larger part is reflecting and of such a shape that a large proportion of the photons produced is concentrated on the other part, while in another design, electromagnetic means is provided in the larger part to concentrate electrons on the other part. A photosensitive layer may also be coated on the wall of the larger part. (D.L.C.)

Materials Testing

5205 NONDESTRUCTIVE TESTING OF SMALL TUBING. J. R. Grieve and A. M. Bounds (Superior Tube Co., Norristown, Penna.). Metal Progr. 78, No. 6, 110-14 (1960) Dec.

Eight nondestructive testing methods (visual, boroscopic, eddy current, dye penetrant, magnetic-particle, ultrasonic, radiographic, and hydrostatic) which can be employed to locate defects in tubing nondestructively are compared. Though eddy-current testing is considered to be the most versatile method in present use, no one test can give a complete answer by itself. Only the proper combination of tests will tell the whole story. (auth)

5206 A NONDESTRUCTIVE ASSAY DEVICE FOR HIGHLY ENRICHED FUEL ASSEMBLIES. Richard V. Babcock and Stanley L. Ruby (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng. 8, 410-15(1960) Nov.

An instrument was developed which can nondestructively determine the U^{235} and boron content of highly enriched, unirradiated fuel assemblies in 5 to 15 min per element. Two nuclear measurement methods are used: counting of the natural radioactivity of U^{235} and neutron attenuation measurements. For MTR and ETR fuel elements, the instrument appears to be accurate to 0.3% and 4.0% in terms of the respective U^{235} and boron contents. (auth)

GEOLOGY, MINERALOGY, AND METEOROLOGY

5207 (NP-9613) THE ORE CONTROLS OF SOME URANIUM VEIN DEPOSITS IN PORTUGAL. Technical Paper No. 26. J. Cameron (Portugal. Junta de Energia Nuclear, Lisbon). 1960. 61p.

Some of the uranium bearing vein deposits of Portugal are described. The uranium ore controls in the veins, which are located in four main districts known as Urgeirica, Reboleiro, Guarda, and Bendada, are studied. The ore controls on eighteen mines were studied, and four of these are described in some detail. Three main vein types occur, red jasper veins, ferruginous white quartz veins, and black and white banded quartz veins. It was found that the red jasper type vein is considerably more favorable to U_3O_8 mineralization when compared to the other two. The relation of the Portuguese uranium region to the other European uranium regions is briefly discussed, and a common continental structural origin is suggested. (W.L.H.)

5208 (NP-9614) AGE OF PITCHBLENDE FROM LENTEIROS, REBOLEIRO-PORTUGAL. J. E. T. Horne. AGE STUDY OF URANINITES FROM THE URGEIRIÇA AND LENTEIROS MINES-PORTUGAL. Technical Paper No. 27. L. R. Stieff and T. W. Stern (Portugal. Junta de Energia Nuclear, Lisbon). 1960. 15p.

The pitchblende specimen came from a shallow depth of 25 m; it consisted of hard massive pitchblende strongly veined by secondaries. The age of the specimen was calculated from the uranium, thorium, and lead contents and the isotopic analysis of the latter. The Pb^{206}/U^{238}, Pb^{207}/U^{235}, and Pb^{207}/Pb^{206} ages for the single specimens for uraninite from the Urgeirica mine are 80, 81, and 126 my, respectively. Ages of 97, 97, and 118 and 86, 86, and 90 my were obtained for two uraninite specimens from the Lenteiros mine. The similarity in Pb^{207}/Pb^{206} ages, even before resolution correction, and the close agreement of the lead-uranium ages from Urgeirica and one of the Lenteiros samples suggest that the ore in both mines was emplaced at the same time. On the basis of the evidence available, an age of 83 ± 8 my seems most probable. (W.L.H.)

5209 (SCTM-211-60(51)) THE U. S. WEATHER BUREAU–SANDIA CORPORATION PROJECT IN WIND CLIMATOLOGY: RESULTS, COMPUTER PROGRAMS, AND MAGNETIC TAPE RECORDS–II (AN IBM 704 PROGRAM FOR CALCULATING ALTITUDE-TIME CORRELATIONS OF WIND). M. K. Weston (Sandia Corp., Albuquerque, N. Mex.). Nov. 1960. 58p. OTS.

A program for calculating altitude-time correlations of wind components on the IBM 704 EDPM is presented. Included are method of computation, instructions for running the program, a copy of the assembled program, and a sam-

ple of computed data in format. The basic data used consist of daily wind readings during a 5-year period (March 1953 through February 1958) at 15 pressure levels (from 950 to 10 mb) at 51 stations. The program is capable of computing correlations having time lags of 0 to 20 days. (auth)

5210 NUCLEAR METHODS FOR SUBSURFACE PROSPECTING. J. G. Beckerley (International Atomic Energy Agency, Vienna). Ann. Rev. Nuclear Sci. 10, 425-60(1960).

A survey was made of literature pertaining to nuclear techniques for measuring in situ the properties of subsurface formations. The nuclear methods reviewed are those in which (a) the response of the emission of prompt or delayed γ rays and/or neutrons is observed in irradiated geological formations and (b) the natural or spontaneous emission of γ rays and/or neutrons by geological formations is observed. A description is given of the techniques applied in aerial and surface prospecting. The economic importance of subsurface prospecting and the fundamental limitations of the nuclear techniques are indicated. Following a discussion of existing "boundary conditions," considerations are given of the status of each nuclear method. The review is concluded by identifying major gaps in the methods and by commenting on the future course of the development of methods for subsurface prospecting. 86 references. (B.O.G.)

5211 DETERMINATION OF THE COEFFICIENTS OF VERTICAL INTERMIXING OF PARTICLES IN A FREE ATMOSPHERE. A. G. Laktionov (Inst. of Applied Geophysics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 838-40(1960) Aug. 1. (In Russian)

Published data on the vertical distribution of particles of $r < 0.1\ \mu$ and $0.1\ \mu < r < 1\ \mu$ indicate an exponential reduction with elevation in free atmosphere. Particle concentrations ($r_{eff} = 0.1\ \mu$ and $10\ \mu > r > 3\ \mu > 3$ r) were measured at elevations of 100, 200, 300, 500, 750, and 1000 m, and then every 500 m up to 3000 m. Characteristic reductions with elevation for three particle fractions measured over land in summer are plotted. (R.V.J.)

5212 AN INVESTIGATION OF THE RADIOACTIVITY OF WATER IN THE ATLANTIC. B. A. Nelepo (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 134, 810-11 (1960) Oct. 1. (In Russian)

A specially designed scintillation spectrometer was used for measuring radioactive elements in the upper 120-m layer of the Atlantic Ocean at 22° 45′ N latitude, 63° 06′ W longitude to 15° 22′ N latitude, 20° 56′ W longitude, Oct. 1–20, 1959. K^{40}, Cs^{137}, Kr^{85}, and Eu^{155} were identified and their distribution indicated an atmospheric character of the deposits (stratospheric fall-out). Three well-defined layers were observed at a depth of 120 m: the upper layer with high specific activity distributed evenly through the layer, the intermediate layer with a sharp drop in specific activity, and the lower layer with small specific activity. The drop in specific activity of each isotope is related to its half life. (R.V.J.)

5213 RARE GASES IN TEKTITES. J. H. Reynolds (Univ. of California, Berkeley). Geochim. et Cosmochim. Acta 20, 101-14(1960) Oct. (In English)

Tektites from a number of localities were examined for their contents of potassium, atmospheric argon, radiogenic argon, atmospheric neon, and possible cosmogenic neon. At 300°K, the coefficient of diffusion for helium in tektite glass from Kalgoorlie, Australia is 4×10^{-10} cm^2/sec. The activation energy for helium diffusion is 0.27 ev. The helium solubility constant is 0.005. Corresponding quantities for neon diffusion are 2×10^{-15} cm^2/sec, 0.61 ev and 0.005. The helium diffusion rate is so high that tektites retain no radiogenic or cosmogenic helium. The recent group of tektites should retain a substantial amount of any cosmogenic neon contained at time of fall. In no case was any excess Ne^{21} detected. From the upper limits of original Ne^{21} content, a maximum "flight time" since last melting was computed for each tektite. For a tektite from Kalgoorlie, this is 28,000 years. This result is in apparent disagreement with the finding by Ehmann and Kohman of radioactive Al^{26} in australites. Potassium–argon ages were computed for each tektite. These range from 0 to 32 m.y. and are usually in agreement with the stratigraphic age of the formations on which the tektites lie, according to presently accepted time scales. These data do not support a recent suggestion that the moldavites of Czechoslovakia and the recently discovered tektites from Georgia, U.S.A. are part of the same fall. (auth)

5214 SPECTROMETRIC MEASUREMENT OF NATURAL AND COSMIC-RAY INDUCED RADIOACTIVITY IN METEORITES. M. A. Van Dilla (Los Alamos Scientific Lab., N. Mex.), J. R. Arnold, and E. C. Anderson. Geochim. et Cosmochim. Acta 20, 115-21(1960) Oct. (In English)

A nondestructive method of analysis of meteorites for natural and cosmic-ray induced radioactivity using low-level γ-ray spectrometry of kilogram samples is reported. Results so far obtained are essentially qualitative but appear to be in agreement with previous chemical measurements of K and Al^{26} in chrondrites and achondrites. Cobalt^{60} was detected in the Ussuri (Sikhote-Alin) siderite (fell 1947) but not in old falls such as Odessa and Canyon Diablo. The rate of production of some interesting cosmic-ray induced activities is discussed. (auth)

5215 DETERMINATIONS OF CONCENTRATIONS OF HEAVY ELEMENTS IN METEORITES BY ACTIVATION ANALYSIS. G. W. Reed, K. Kigoshi, and A. Turkevich (Argonne National Lab., Ill. and Univ. of Chicago). Geochim. et Cosmochim. Acta 20, 122-40(1960) Oct. (In English)

Barium, mercury, thallium, lead, bismuth, and uranium contents, and isotopic composition of stone and the troilite phase of iron meteorites were determined by neutron activation analysis. Two groups of chondrites were observed: the one containing enstatite and carbonaceous chondrites has orders of magnitude more of the chalcophilic elements studied than other chondrites. Barium and uranium do not show this variation. The lead in this group is primordial in its 208/204 isotopic composition as might be expected from the Pb/U ratio. Some of the nuclear and geochemical implications of the results are suggested. (auth)

5216 THE UNIFORMITY OF CONCENTRATION OF LITHOPHILE ELEMENTS IN CHONDRITES—WITH PARTICULAR REFERENCE TO Cs. L. H. Ahrens, R. A. Edge, and S. R. Taylor (Univ. of Cape Town). Geochim. et Cosmochim. Acta 20, 260-72(1960) Nov. (In English)

The dispersion of concentration of the lithophile elements Li, Na, K, Rb, Mg, Ca, Sr, Ba, Al, Sc, Eu, Si, Ti, Zr, Th, and U is examined in chondrites. Where twenty or more analyses have been made, relative deviations have been calculated; these range from 5 to 29%. Some of the variation is clearly due to analytical error, and it is concluded that the relative deviations of most, perhaps all, lithophile elements is near the lower limit (5%) of the above range. Such small dispersion of concentration for a wide variety of elements, including Li, K and Mg, which are sensitive to fractionation, indicates that chondrites have

come from a source with an exceptionally uniform composition. It is concluded further that variation of concentration of a lithophile element in the silicate phase, as distinct from the meteorite as a whole, may be even smaller and that the ratio of one lithophile element to the other lithophile elements may turn out to be extremely small indeed. Analytical data of a very high order of excellence (relative deviation of 1 to 2%) for all elements are evidently required to estimate such small variations precisely. The second part is concerned specifically with cesium. This element has been estimated spectrochemically in K–Rb–Cs fractions obtained by ion exchange techniques from six chondrites and seven specimens of basic rock. In the chondrites, the cesium content (av. 0.12 ppm) and the K/Cs ratio (av. 7000) remains constant to within the precision of the method of analysis. The magnitude of the average agrees with that of Webster, Morgan, and Smales (0.09 ppm), but the small variation of the cesium concentration and of the K/Cs ratio contrasts with their observations as they report large variations (×30 or more). The K/Cs ratio in the seven basic rocks is fairly uniform (in contrast with granites) and similar in general magnitude to that in the chondrites. (auth)

5217 DEUTERIUM ABUNDANCE OF NATURAL WATERS. Yoshio Horibe and Mituko Kobayakawa (Tokyo Metropolitan Univ.). Geochim. et Cosmochim. Acta 20, 273-83(1960) Nov. (In English)

The deuterium abundance of natural water of various sources has been determined by the use of a deuterium mass spectrometer. The absolute deuterium contents of the reference sample Nos. 1 and 1a of the U. S. National Bureau of Standards were found to be 0.0149 and 0.0128 mole % D_2O, respectively, by the comparison of the samples with the standard samples of known deuterium content. Relative enrichment of No. 1a to No. 1 $(R_{1a}-R_1)/R_1 \times 100$ was 14.13 ± 0.23, which agrees perfectly to the value reported by Craig. The variation of deuterium contents of tap waters of Tokyo and Osaka during the last two years were within ±1%, and any seasonal regularities could not be detected. Marine waters of the West Pacific have almost the same deuterium content as those of the Pacific coast of the United States. Marine waters at various depths of the Antarctic showed relatively large variation of deuterium content (from +0.84 to −1.16% on the SMOW-scale), whereas the samples from the Black Current of the Pacific showed little variation. It was found that the deuterium content of spring water suggests the origin of springs in some cases. (auth)

5218 THE ISOTOPIC COMPOSITIONS AND CONCENTRATIONS OF LEAD IN SOME CHONDRITIC STONE METEORITES. D. C. Hess (Argonne National Labs., Ill.) and R. R. Marshall. Geochim. et Cosmochim. Acta 20, 284-99(1960) Nov. (In English)

Microgram quantities of lead were volatilized from the chondrites and purified for mass spectrometric analysis. Aliquots of approximately 1 μg were surface-ionized by use of the boric acid technique. The isotopic compositions found range from highly radiogenic lead, in the case of Richardton, to leads in the other three chondrites that are substantially less radiogenic than average lead in the crust of the earth. From recent concentration determinations by the isotopic dilution method, it seems that the amount of lead in Beardsley is about 0.13 ppm and that in Richardton about 0.06 ppm. The leads in these meteorites are consistent within a factor of approximately 2 with the lead–lead ages and the independently measured uranium and thorium concentrations. The lead–lead age for Richardton is the same as that found by Patterson (1955) for Nuevo Laredo, being 4.6 aeons. The lead concentration measured for Forest City is 0.09 ppm, whereas that for Holbrook is 0.28 ppm. Holbrook is quite anomalous in containing 2.5 times the amount of radiogenic lead that can be explained by the accumulation of decay products in situ with a primeval lead that had the isotopic composition of the lead from the troilite in the Canyon Diablo and Henbury iron meteorites. The total amount of lead on the surface of a meteorite appears to be comparable to the total amount inside. The isotopic composition of this surface lead indicates that it is principally terrestrial lead. (auth)

5219 THE ABSOLUTE ABUNDANCE OF THE CHROMIUM ISOTOPES IN CHROMITE. G. D. Flesch, H. J. Svec, and H. G. Staley (Ames Lab., Ames, Iowa). Geochim. et Cosmochim. Acta 20, 300-9(1960) Nov. (In English)

Isotopic assays have been made on the chromium in eighteen chromite samples from countries responsible for 81% of the chromite production between 1900 and 1950. The use of mixtures of separated isotopes to determine the accuracy indicates that the measurements are absolute. On the basis of these assays, the natural abundances of the chromium isotopes in atoms per cent are: $Cr^{50} = 4.352 \pm 0.024$, $Cr^{52} = 83.764 \pm 0.036$, $Cr^{53} = 9.509 \pm 0.027$, and $Cr^{54} = 2.375 \pm 0.018$, where the limits cited represent 3σ. No variation in the isotopic composition of the chromium in any of the chromites examined was found within the stated limits. The chemical atomic weight, computed on the basis of these abundance values and the latest accepted values for the masses of the involved isotopes, is $51.998_1 \pm 0.001_3$. (auth)

5220 URANIUM CONTENT OF OXIDIZING OILS. A. K. Lisitsin (Inst. of the Geology, Petrography, Mineralogy, and Geochemistry, Academy of Sciences, Moscow). Geokhimiya No. 7, 634-9(1960). (In Russian)

Data are given on the uranium distribution in oils and in ashes of oils from paleogene sediments of the Fergana depression, depending on their specific weight and general ash content. Results of uranium extraction from natural waters by oils also are given. The results show that the principal enrichment of oils in uranium occurs during their oxidation under the influence of infiltration sheet waters, the capacity for uranium extraction from underground waters increasing with the increase of the oxidation degree of oils. (tr-auth)

5221 ON E. K. GERLING'S METHOD OF DETERMINING THE ACTIVATION ENERGY OF RADIOGENIC GASES IN MINERALS. Kh. I. Amirkhanov, S. B. Brandt, and E. N. Bartnitskiĭ Geokhimiya No. 7, 646-9(1960). (In Russian)

An analysis is made of diffusion from a 2R thick plane in order to verify the method of E. K. Gerling (Tr. Rad. Inst 5, 155, 1957) based on well-known equations for ideal diffusion. The analysis does not consider heterodiffusion, which explains the transition phenomenon in minerals. (R.V.J.)

5222 APROPOS OF THE ARTICLE OF V. I. BARANOV AND L. A. KHRISTIANOVA "RADIOACTIVITY OF THE WATERS OF THE INDIAN OCEAN" (GEOKHIMIYA, NO 7, 1959). S. M. Grashchenko, Yu. V. Kuznetsov, K. F. Lazarev, V. K. Legin, and D. S. Nikolaiev. Geokhimiya No. 7, 650-1(1960). (In Russian)

Data indicating an increased concentration of uranium in the southwestern region of the Indian Ocean are analyzed and certain conclusions, based on the geochemistry of radioactive elements, are examined. (R.V.J.)

5223 APROPOS OF THE REMARKS OF S. M. GRASHCHENKO, ET AL., TO THE ARTICLE "RADIOACTIVITY OF THE WATERS OF THE INDIAN OCEAN." V. I. Baranov and L. A. Khristianova. Geokhimiya No. 7, 651-2(1960). (In Russian)

Data on the thorium content are compared with previously reported data. Previous conclusions on the increased content of uranium in the southwestern region are confirmed. (R.V.J.)

5224 CHLORINE-36 RADIOACTIVITY IN RAIN. O. A. Schaeffer, S. O. Thompson, and N. L. Lark (Brookhaven National Lab., Upton, N. Y.). J. Geophys. Research 65, 4013-16(1960) Dec. (BNL-4927).

Cosmic rays and nuclear explosions are adding radioactivity to the atmosphere from which it is then removed by rainfall. The investigation of these activities furnishes a means of obtaining new information of significance in geological problems as well as in the understanding of the hazards of nuclear fall-out. Cl^{36} is an interesting isotope for such a study as it has a relatively long half life, 308,000 years, and at the same time is very soluble in water. Relatively high levels of Cl^{36} activity were found in rain. The levels are several orders of magnitude above the level to be expected from cosmic-ray production. The Cl^{36} is almost surely the result of neutron irradiation of sea water by nuclear explosions. (auth)

5225 IODINE CONTENT OF METEORITES AND THEIR I^{129}–Xe^{129} AGES. Gordon G. Goles and Edward Anders (Univ. of Chicago). J. Geophys Research 65, 4161-4(1960) Dec.

Iodine and tellurium abundances in chondritic meteorites were determined by neutron-activation analysis. For bronzite and hypersthene chondrites (6 analyses), iodine abundances from 37 to 104 ppb were found; for enstatite and carbonaceous chondrites (9 analyses), the range was from 127 to 560 ppb. The tellurium abundances ranged from 0.42 to 0.73 ppm and 1.23 to 3.4 ppm, respectively. I^{129}–Xe^{129} decay intervals, measured from the cessation of nucleosynthesis, were calculated for the meteorites Richardton (119^{+4}_{-8} m.y.) and Indarch (97^{+11}_{-6} m.y.), using the continuous nucleosynthesis model. The significance of these results is discussed. (auth)

5226 TEN YEARS OF EXPLORATION AND TREATMENT OF URANIFEROUS ORES. L. Vuchot (Commissariat à l'Énergie Atomique, [Paris]). Rev. ind. minérale 41, 766-87(1959) Oct. (In French)

A survey is presented of French nuclear activity and resources. The topics surveyed are: Uranium and Thorium Ores, Instantaneous Determination of Content, Protection Against Radiation, Mines, Methods for Exploration in Mined Areas, Pre-Concentration of Ores, Ore Concentration by Physical Means, Chemical Treatment, Personnel, and French Potential for Exploration and Treatment of Ores. (T.R.H.)

5227 URANIUM RESEARCH. DEVELOPMENT OF METHODS. A. Lenoble (Commissariat à l'Energie Atomique, [Paris]). Rev. ind. minérale 41, 788-99(1959) Oct. (In French)

Uranium prospecting methods are discussed. The discussion includes radiometry, geochemistry, geophysics, mine research, geological control, and estimation of reserves. (T.R.H.)

5228 CROUZILLE DISTRICT–MINES, QUARRIES, CHEMICAL PLANT. R. Avril (Commissariat à l'Énergie Atomique, [Paris]). Rev. ind. minérale 41, 830-50(1959) Oct. (In French)

The history of the uranium industry in France is reviewed, and a description is given of prospecting and processing in the Crouzille district. The ore processes are described, and the general organization of the district is outlined. (T.R.H.)

5229 DEPOSITION OF URANIUM IN SALT-PAN BASINS. Kenneth G. Bell. U. S. Geol. Survey. Professional Paper No. 354-G 161-9(1960). $0.20(GPO).

Drainage waters carry minute quantities of uranium into oceans, inland seas, and lakes, and when bodies of water evaporate completely in desiccating salt-pan basins, the uranium must be deposited together with all other dissolved materials. The ratio of uranium to total evaporite sediments is approximately $1:2 \times 10^7$. The distribution of uranium in salt-pan basin sediments is not completely known. Some organic-rich muds, and phosphatic sediments deposited in desiccating basins may contain uranium in amounts as large as 0.0% per cent. Uranium may be adsorbed on clays that are deposited with some evaporite sediments. These muds, phosphatic sediments, and clays may remove nearly all of the dissolved uranium from the water of some basins. Anhydrite, gypsum, halite, and potassium-bearing evaporite minerals probably are the lease uraniferous of all rocks in the earth's crust; their uranium contents generally are less than 0.00001 per cent. Within salt-pan basins where oxidizing conditions tend to prevail, and no significant amounts of organic-rich muds, clays, and phosphatic sediments are deposited, highly soluble uranium salts remain in solution and are deposited only as the basin finally is completely desiccated. These final highly soluble evaporite sediments are not likely to be preserved because they are subject to removal by wind erosion and leaching. (auth)

5230 A GUIDE TO THE KNOWN MINERALS OF TURKEY. Revised. C. W. Ryan. Ankara, Mineral Research and Exploration Institute and U. S. Operations Mission to Turkey, 1960 (Reprint). 204p.

Information is presented concerning the known minerals of Turkey. The types of ore bodies, geographical locations of deposits, descriptions of rock environments, and theories of origin are given. The minerals are divided into the following groups: precious, nonferrous, and minor metals; iron, ferro-alloy metals, metallurgical and refractory materials, mineral fuels, and residues; ceramic, industrial, and manufacturing materials; and chemical, fertilizer, abrasive, and miscellaneous materials. (M.C.G.)

HEALTH AND SAFETY

5231 (A/AC.82/G/L.474) MEASUREMENT OF BONE MARROW AND GONADAL DOSE FROM THE CHEST X-RAY EXAMINATION AS A FUNCTION OF FIELD SIZE, FIELD ALIGNMENT, TUBE KILOVOLTAGE, AND ADDED FILTRATION. Edward R. Epp, Herbert Weiss, and John S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 1, 1960. 37p.

Detailed measurements of bone marrow and gonadal dose were made in a realistic human phantom undergoing the conventional postero-anterior and lateral chest x ray procedures over a wide range of parameters. The parameters included different field sizes, small misalignments of the useful beam, and tube kilovoltages of 60, 80, 100, and 120 kvp with various combinations of added filtration. The method of measurement involved the use of small ionization chambers, which were designed to be sensibly independent of energy, direction, and intensity of incident x radiation.

The results are expressed in dose units per milliampere-second of x-ray machine exposure. A study of radiologically acceptable film latitude was made to allow intercomparison of doses for the various beam qualities. The results show the importance of beam collimation and alignment in minimizing the dosage delivered to the active bone marrow and reproductive regions. By interpolation, estimates of bone marrow and gonadal exposure may be made for any chest x-ray procedure using parameters within the range studied. (auth)

5232 (A/AC.82/G/L.479) THE ENVIRONMENTAL INCREASE OF CESIUM-137 SINCE 1957 TO 1960. Noboru Yamagata (Japan. National Inst. of Public Health. Radiation Health Lab.) and Shunji Matsuda (Gunma Univ., Kiryu, Japan. Kiryu Coll. of Technology). Aug. 1960. 5p.

This paper presents a tabulation of Cs^{137} data from Kiryu College of Technology, Gunma University, from 1957 through 1960. Cereals, vegetables, land animals, and soil samples were collected from a farm near Kiryu, Gunma Prefecture, to minimize geographical variation. The season of collection was fixed by sample to minimize the possible variation due to the seasonal variation of fall-out rate. Tabulated data show the increase of cumulative ground deposit of Cs^{137} by a factor of 20 from May 1957 to January 1960. An increase of N-ammonium acetate extractable Cs^{137} by a factor of 5 was observed in the same period. (auth)

5233 (A/AC.82/G/L.489) THE Cs 137 AND Sr 90 CONTENT IN DRIED MILK SAMPLES FROM 1958 AND 1959. K. Löw and S. Higgroth (Sweden. Försvarets Forskningsanstalt, Stockholm). June 1960. 6p.

Measurements of Cs^{137} and Sr^{90} in dried milk samples from 1958 and 1959 are reported. A good correlation between the concentrations of these nuclides is found. (auth)

5234 (A/AC.82/G/L.490) RESULTS OF STRONTIUM NINETY DETERMINATIONS ON SAMPLES FROM LUCAS HEIGHTS AND RICHMOND, N.S.W. 1959-1960. (Resultats de Determinations du Strontium-90 dans des Echantillons Provenant de Lucas Heights et de Richmond (N.S.W.) 1959-1960). L. E. Smythe and P. S. Davis (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1960. 25p.

Submitted to Third Australasian Conference on Radiation Biology, Univ. of Sydney, Aug. 15-18, 1960.

Data are tabulated on the levels of Sr^{90} and other low-level β emitters in samples of rain water, grass, soil, milk, eggs, animal bone, river water, silt, and oysters collected from two sites in Australia during 1959 and 1960. (C.H.)

5235 (A/AC.82/G/L.491) AUTORADIOGRAPHIC AND MICROSCOPIC EXAMINATION OF NUCLEAR-WEAPON DEBRIS PARTICLES. J. Sisefsky (Sweden. Försvarets Forskningsanstalt, Stockholm). Mar. 1960. 37p.

Radioactive debris in air from the Russian nuclear weapons tests in Feb. and Oct. 1958 were collected on glass-fiber papers. Active particles were shown on autoradiographs of the filters. The particles were isolated, measured, and prepared in order to make possible examination and photography under the microscope, by autoradiographical methods. Beta- and gamma-decay curves for single particles were made and the relation between activity and particle size was investigated. (auth)

5236 (ARCRL-3) STRONTIUM 90 IN HUMAN DIET IN THE UNITED KINGDOM, 1959. Report No. 3. (Gt. Brit. Agricultural Research Council. Radiobiological Lab., Grove, Berks, England). 1960. 60p. (A/AC.82/G/L.487).

Results are reported from a survey of Sr^{90} in the human diet in the United Kingdom during 1959. Data are compared with those from 1958. (C.H.)

5237 (CF-59-11-115) THE EFFECTS OF A DETONATION WITHIN A PROCESS CELL. J. P. Nichols (Oak Ridge National Lab., Tenn.). Nov. 30, 1959. 13p. OTS.

Estimates are made of the effects of a detonation within a process cell. The effects and calculated magnitude of the Nov. 20, 1959, Bldg. 3019 explosion are compared with what is considered to be the maximum credible explosion. (auth)

5238 (LAMS-2455(p.83-90)) MILK MONITORING PROGRAM. B. E. Clinton, J. M. Allen, and E. C. Anderson (Los Alamos Scientific Lab., N. Mex.).

Results are given from measurements of natural and fall-out radioactivities in milk samples from 55 stations in the United States and Canada. Data on samples collected in 1960 are compared with those collected in 1959. (C.H.)

5239 (LAMS-2455(p.206-19)) NEUTRON-INDUCED ACTIVITY IN HUMANS AS A DOSIMETRIC PROCEDURE. E. R. Ballinger, P. S. Harris, and J. H. Larkins (Los Alamos Scientific Lab., N. Mex.).

A study was made of the feasibility and techniques of using neutron-induced body activity as a measure of dose, and as a personnel monitoring and casualty assessment procedure. A portable transistorized body sodium activity meter was designed, constructed, and calibrated for use as a casualty assessment device for personnel exposed to fast neutron fluxes in the range of 10 to 1000 rads. The units were calibrated with the aid of plastic mannequins exposed to fission neutrons from the Godiva II critical assembly or to thermal neutrons from the Omega West reactor to indicate the incident neutron rads corresponding to levels of Na^{24} activity. It was concluded that a lightweight, portable, and self-contained personnel neutron monitoring device can be constructed to detect exposures to neutrons in excess of 10 rads whole-body dose, based upon external measurements of body sodium activity. The absorbed dose may be read directly if the meter is calibrated to the incident spectra. (C.H.)

5240 (NP-9623) INHALATION DOSE FROM AIRCRAFT IN FLIGHT. Harry Levin (Marquardt Corp., Van Nuys, Calif.). Nov. 17, 1959. 28p. Contract AF33(616)-6214. (TD-218-1).

In the application of air-cooled nuclear power plants for aircraft, it is important to evaluate inhalation dose on the ground resulting from various flight conditions. Methods of radiation inhalation dose calculation for three principal conditions of flight are presented; these conditions are flight in the crosswind direction, flight in the wind direction, and orbital flight. The methods deal with emission of fission products by recoil mechanisms only from unclad fuel elements. (W.L.H.)

5241 (TID-11199) OFF-SITE ANIMAL INVESTIGATION PROJECT. Third Annual Report. Garland R. Farmer, comp. (Office of Test Operations, AEC, Las Vegas, Nev.). June 30, 1960. 8p. OTS.

The objectives of the Off-Site Animal Investigation Project, inaugurated in 1957, have remained unchanged during the past year. These are to enhance the Nevada Test Site Off-Site/rancher relationship through an active investigation project in their interests and to provide further in-

formation as to the status of the off-site animals in their environment, with special emphasis on their radioactive isotope uptake from fall-out. Isotope uptake of the animals is emphasized, as well as gross and microscopic histopathological examinations. To date no effects have been noticed on these cattle. Their reproduction rate is normal and the animals maintain themselves in a satisfactory state. There have been no diseased conditions in the herd which would suggest ill health or substandard resistance. Since there have been no bomb tests and subsequent release of fall-out material, the uptake of these isotopes has been negligible and this is largely responsible for the brevity of this report. After three years, we may conclude there has been no noticeable radiation damage to this herd. The project remains of interest to the local ranchers who inquire closely about the welfare of the herd. We may conclude that it is serving a very useful purpose in relation to Test Site/rancher understanding and relations. It is felt that it is quite important to continue the herd and project even though tests have ceased because this will enable a baseline of isotope uptake to be established for future reference. (For preceding period see AECU-4613.) (auth)

5242 (TID-11212) RESEARCH AND DEVELOPMENT OF PROTECTIVE RESPIRATORY EQUIPMENT. Progress Report [for] July 1, 1960 to October 1, 1960. Leslie Silverman and William A. Burgess (Harvard Univ., Boston. School of Public Health). 12p. Contract AT(30-1)-2355. OTS.

Progress is reported in the development of test methods for use in evaluating respiratory protective equipment. Respiratory sampling equipment was constructed which is lightweight, portable, and suited to off-site evaluation of respiratory protective devices. Evaluation of additional standard respirators indicates that with present equipment only full-face masks meet the maximum penetration criterion of 0.1%. (C.H.)

5243 (JPRS-5761(p.178-88)) DROP IN THE RADIOACTIVITY LEVEL OF ATMOSPHERIC AIR AS A RESULT OF STOPPING NUCLEAR WEAPONS TESTING. Yu. V. Novikov and I. P. Korenkov. Translated from Med. Radiol. 5, No. 7, 66-71(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 24374.

5244 (JPRS-5761(p.192-206)) TECHNICS—DETERMINATION OF THE QUALITY AND QUANTITY OF SCATTERED RADIATION IN AN IRRADIATED MEDIUM. B. M. Aliev (Aliyev). Translated from Med. Radiol. 5, No. 7, 72-7(1960).

The design and calibration are described of an ionization chamber for measuring doses of scattered radiation during deep x-ray therapy. (C.H.)

5245 THE CONTINUOUS MONITORING OF THE SEDIMENTATION OF "HOT PARTICLES" FROM THE ATMOSPHERE. H. Meurers (Technischer Überwachungsverein Köln, e.V., Dusseldorf). Atomkernenergie 5, 416-18(1960) Nov. (In German)

A complete description is given of a measuring procedure undertaken in the study of "hot particles." The black dots of the autoradiograph taken of adhesive sheets were classified as to "size" by means of photometry. The results of experiments done in 1959 and the beginning of 1960 show a correlation between the density of the dots and the total radioactivity. An objective definition can be formed of the measuring data, so that it is quite applicable for an extensive check under definitely established conditions. The order of the detection limit can be given from a gaging test. All the basic problems of this procedure are sufficiently well known from many publications. (auth)

5246 A REMARK ON THE EFFECT OF ORGANIC MATTER IN THE MIGRATION OF STRONTIUM-90 IN THE SOIL. Claude Gailledreau (Commissariat à l'Énergie Atomique, Saclay, France). Énergie nucléaire 2, 287-9 (1960) Sept.-Oct. (In French)

The migration of Sr^{90} in the soil is strongly accelerated under conditions in which anaerobic decomposition of vegetable matter develops. This phenomenon was shown in the Saclay soil under laboratory conditions. The rapid depletion of limestone was also shown. The behavior of strontium ions and calcium ions was analogous. (tr-auth)

5247 ENVIRONMENTAL RADIATION SURVEY AROUND A NUCLEAR POWER STATION. John D. Abbatt, J. R. A. Lakey, and D. J. Mathias. G.E.C. Atomic Energy Rev. 2, 200-4(1960).

In order to be able to evaluate any increase in radioactivity in the area around an operating nuclear power station, it is necessary to carry out an environmental background survey over a period of at least one year before operation begins. Some 30 sampling points are desirable, their number and siting depending upon a number of considerations; they are listed. A mobile laboratory may be used to collect samples of biological material, soil, and water and to measure airborne activity. The majority of samples are returned to a main laboratory for assay of their α, β, and γ activity, using apparatus that is described. Some preliminary results given for the survey around Hunterston show that the relatively simple and cheap equipment used is sufficiently sensitive to detect fall-out from nuclear-weapons tests. (auth)

5248 GAMMA RADIOACTIVITIES OBSERVED IN TEA. Sadakiyo Hori (Japan Hydrographic Office, Tokyo) and T. R. Folsom. J. Radiation Research (Japan) 1, 10-13(1960) June. (In English)

An excessive amount of Cs^{137} activity was found in Japanese tea, which reached the United States in 1957 and 1958, by a γ-ray spectrometer. An estimate was made of the potassium content and also of the amount of fall-out activity of Zr^{95}. The γ activities of other tea samples and California plants were examined with the same method for comparison. (auth)

5249 ON THE SURVEY OF THE LEAKAGE OF COBALT-60 SOURCES. Hirotake Kakehi, Guio Uchiyama, Noboru Arimizu, and Kenji Saegusa (Chiba Univ., Japan). J. Radiation Research (Japan) 1, 54-60(1960) June. (In English)

In the Chiba University Hospital, a new type of teletherapy unit with pneumatic transference containing 100 curies of Co^{60} coin typed sources was set up. After a repetition of tests, a considerable amount of radioactive contamination was found on various parts of the unit and on the floor of the room. The contamination of the unit was surveyed, and it was found that this had occurred because of a leakage of Co^{60} dust from the source capsule, namely, by its incomplete encapsulation. A survey was also made on some telecobalt units of a conventional type, and some positive findings were noted. In this report causes and countermeasures are discussed concerning the leakage of Co^{60} which caused a considerable amount of contamination. To prevent radiation hazards because of radioactive contamination, periodical wipe tests should be made on the Co^{60} units. (auth)

5250 MEASUREMENTS ON THE SPECTRAL DISTRIBUTION OF THE ABSORBED DOSE DELIVERED BY

Co^{60} GAMMA RAYS. Nobuo Oda (Rikkyo Univ., Tokyo) and Hirosi Suzuki. J. Radiation Research (Japan) 1, 70-80 (1960) June. (In English)

A method is presented which makes it possible to measure directly the absorbed dose in soft tissue exposed to γ and x rays and in addition to clarify the dependence of the spectral distribution of absorbed dose on the size of tissue element. The term TEIT (transferred energy per individual track) is introduced, and the absorbed dose is expressed in the form of the spectral distribution as a function of TEIT. A brief explanation indicates the relation between the spectral distribution in TEIT and that in LET (linear energy transfer). Actual measurements were performed on the absorbed dose in soft tissue represented by plastic scintillators of various sizes exposed to Co^{60} gamma rays using a scintillation spectrometer. From three types of measurements the following was derived: the variation of the spectral distribution of dose in TEIT with the tissue size; the variation of dose with depth; and the characteristics of dose close to the bone-tissue interface. (auth)

5251 UTILIZATION OF A γ SPECTROMETER FOR DETECTION OF NORMAL OR ABNORMAL RADIOACTIVE CONTAMINATION IN THE INDIVIDUAL. L. Jeanmaire, H. Fourniguet, and A. Lansiart. J. radiol. et électrol. 40, 548-55(1959). (In French). (CEA-1374)

The whole body counters employed in the Commissariat à l'Energie atomique are fitted with a NaI crystal (20 cm in diameter and 10 cm high), a linear amplifier, and a 25-channel selector. The protection is obtained by means of a lead shield only 5 cm thick. This spectrometer is sensitive enough to detect the natural radioactivity of an individual. Therefore the rapid detection of an accidental contamination by a γ emitter may be performed for doses which are generally much lower than the maximum permissible doses recommended by the International Commission on Radiological Protection. The device can also be employed to provide some basic information in the case of neutron exposure. (auth)

5252 CAN PEACEFUL NUCLEAR EXPLOSIONS BE CONDUCTED SAFELY? Charles E. Violet (Univ. of California, Livermore). Mining Congr. J. 79-83(1960) Mar. (UCRL-6215)

The important safety problems associated with peaceful applications of nuclear energy are considered. The peaceful applications considered are partially or completely contained explosions. Local and world-wide fall-out, ground water contamination, induced radioactivity, ground-motion effects, and airblast effects were studied. Results indicate that if the site is sufficiently remote, approximately 30 miles for major construction, the applications of nuclear explosions can be carried out safely. (M.C.G.)

5253 IONIZATION DOSIMETRY AND DOSE DISTRIBUTION OF FAST ELECTRONS IN BONE TISSUE. Benno Markus (Universitäts-Hautklinik, Göttingen, Ger.). Strahlentherapie 113, 379-93(1960) Nov. (In German)

It is shown that, for electron energies of about 1 kev to 15 Mev for bones of mean composition, air represents a good energy-independent dosimeter substance and furthermore, that water, the tissue equivalent phantom mass M 3 on the one hand, and sulfur on the other hand can be considered as limiting substances for all occurring cartilage and bone tissues in men. With a special ionization chamber and inhomogeneous strata phantoms of M 3 and sulfur, the air-ionization in different soft tissue-bone compositions between 3 and 15 Mev electron-energy was measured. The determination of the absolute specific dose (ergs/cm^3) from the ionization measurements is shown. An approximate computation of the extrapolated electron range in the inhomogeneous phantom is described. The influence of the reflection through enclosed bone layers on the superficial dose was measured for practical limiting cases. Two practical examples demonstrate the superiority of the electron therapy as opposed to an x-ray or gamma therapy in the consideration of bone and tissue protection. (auth)

5254 LOCAL AND PERSONNEL DOSE IN TELEGAMMATHERAPY. Hans-Joachim Frischbier and Helmut Kuttig (Universität, Heidelberg, Ger.). Strahlentherapie 113, 402-8(1960) Nov. (In German)

The measurements of local dose performance isodoses in a telegammatherapy department and the results of the supervision of radiation protection of the personnel are reported. From this inference it is deduced that, through the knowledge of dosage distribution of the radiation leakage and through the rationalization of the operation procedure, the personal dose, even with a high patient frequency, can be kept extremely low. (auth)

5255 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NUMBER 21 FOR APRIL-JUNE 1960. Tokyo, The Japan Meteorological Agency, 1960. 97p. (In English and Japanese)

Data are tabulated on the radioactivity in samples of dust and rain water collected at a number of stations in Japan during April, May, and June 1960. (C.H.)

5256 REMOVAL DOSE FOR MONITORING EFFECTS OF X-RAYS AND GAMMA RAYS. R. L. Hickmott (Wright Air Development Center, Wright-Patterson AFB, Ohio). p.40-2 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The merits of removal dose (the dose associated with energy transfer from the photons to the kinetic energy of the fast secondary particles) as the dose quantity for radiation effect studies are compared with the absorbed dose (energy degraded to heat). Since the removal dose is geographically a point function, whereas the absorbed dose is not so localized, it is not as desirable as the absorbed dose, but they are practically equal for many samples and hence can be used interchangeably. In the case of nonhomogeneous samples where the absorbed dose varies widely from point to point, an environmental dose is often used instead, generally either exposure dose (roentgen-removal dose air) or carbon dose (removal dose carbon). The advantages and disadvantages of the removal dose as an environmental dose for homogeneous samples are discussed; it is excellent where the material in which the dose is measured and the sample have close atomic numbers. (D.L.C.)

5257 DOSIMETRY NOMENCLATURE IN THE UNITED STATES. A. N. Tschaeche (Reynolds Electrical & Engineering Co., Inc., Mercury, Nev.). p.43-55 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The history of dosimetry, the work done in the field of dosimetric systems and nomenclature by five national and one international committee, the current nomenclature attendant to material dosimetry, and some of the current problems in the field are presented. The terms discussed are: absorbed dose, dosimetry, carbon dose, cadmium ratio, exposure dose, and neutron energy ranges. A new definition is suggested for absorbed dose. The concept of reference dose is discussed and defined. The national committees concerned with nuclear technology are: (1)

Aircraft Nuclear Propulsion Advisory Committee for Nuclear Measurements and Standards, (2) the National Research Council's Subcommittee on High Level Dosimetry, (3) the ASTM Joint Subcommittee, of Committees D-9 and D-20, on Radiation Effects to Plastics and Electrical Insulating Materials, (4) the ASTM Task Groups on Dosimetry, of Committee E-10 on Radioisotopes and Radiation Effects, (5) the Nuclear Standards Board's Subcommittee on Nuclear Terms, and (6) the International Commission on Radiological Units and Measurements. The conclusions are that confusion exists in the field but that the nature of the confusion is recognized and work is being done to remedy the situation by establishing generally accepted nomenclature and methods for material dosimetry. (auth)

5258 DOSIMETRY IN EUROPE AND THE USSR. J. H. Guill and John Moteff (General Electric Co., Cincinnati). p.56-67 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

A summary of the work done on dosimetry in Western Europe and the Soviet Bloc countries is presented together with a brief account of the growth of radioisotope production and reactor construction in these countries. Among the topics on which papers have been published are luminescence dosimetry, scintillators, photomultipliers, thimble ionization chambers, secondary electron spectra, geometry and self-absorption, slow and fast neutron counting, germanium np junctions, and chemical dosimeters. The present situation regarding standardization of dosimetry is discussed, especially in the case of the definition of the roentgen. Tables presenting a historical survey of dose units and international neutron source calibration comparisons are given. (D.L.C.)

5259 STANDARDIZATION OF TERMINOLOGY FOR GAMMA AND ELECTRON BEAM RADIATION SOURCES. George E. Danald (Quartermaster Food and Container Inst., Chicago). p.79-82 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Over five years' experience in utilizing nearly 20 different sources of γ ray and electron beam radiation sources have indicated a critical need for some degree of uniformity on the part of the source owner or operator in specifying the performance of the source, his methods of measuring its field or beam, and the manner of charging customers for its use. Standards of dose delivered, specifications of the field or beam, and a set of experimental or environmental conditions which the vendor should make known to a prospective user of a radiation source are recommended. This information should be given in terminology which is uniform from source to source, thus enabling a user to select a source best suited to his specific needs. (auth)

5260 DETERMINATION OF RADIOACTIVE MATERIALS IN WATER. Franklin B. Barker (U. S. Geological Survey, Denver). p.278-88 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The U. S. Geological Survey has adopted methods for measuring the concentrations of certain radioactive materials in water. The methods described are useful in hydrogeochemical studies and for determining the conformance of potable water with health standards. Gross concentrations of α- and β-emitting nuclides are determined by measuring with a suitable counter the activity of the residue left upon evaporation. Sensitivities of about 1 $\mu\mu$c per 100 mg of solids for the determination of α activity and of 1 to 5 $\mu\mu$c per 100 mg of solids for the determination of β activity may be obtained. Radium is determined by either of two carrier-precipitation methods depending upon the accuracy desired or the necessity for measuring concentrations of individual radium isotopes. The sensitivities vary from 0.1 to 1.0 $\mu\mu$c per liter depending upon calcium concentration. Radiostrontium is determined by a multiple precipitation method having a sensitivity of about 1 $\mu\mu$c per liter. Uranium is determined to 0.1 ppb by a fluorometric procedure. (auth)

5261 SHIPPING OF RADIOACTIVE MATERIAL AT THE NATIONAL REACTOR TESTING STATION. Safety and Fire Protection Bulletin 6. Ralph V. Batie and D. E. Patterson (Idaho Operations Office. Safety and Fire Protection Branch, AEC. Revised October 1960. 57p. GPO.

Procedures and problems associated with the transportation of a wide variety of radioactive materials are reviewed. Operations at the National Reactor Testing Station are summarized. Although different contractors operate the various plants, a considerable volume of material is moved between them. There is only one Chemical Processing Plant, and most of the expended fuel is shipped there for processing. The Materials Testing Reactor provides irradiation services, and irradiated material from there is shipped both off and on site. Contaminated equipment is shipped between the various home plants and various wastes and contaminated equipment are moved to a burial ground for disposal. All types of shipments are discussed. Equipment and procedures are described and illustrated photographically. Data are appended on shipping containers and factors influencing load stability on a vehicle. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

5262 (AAEC/E-48) THE USE OF A RADIOACTIVE TRACER (BROMINE 82) TO STUDY FLOW PATTERNS IN A SUGAR SUBSIDER. W. R. Ellis (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales) and L. R. Brain (Australia. Bureau of Sugar Experiment Stations, Brisbane). Apr. 1960. 20p.

The use of radioactive Br^{82} to trace flow patterns in a sugar clarifier is described. The results show that the raw solution goes first to the bottom of the subsider then rises essentially as a layer that becomes progressively more diffuse by mixing with the solution, both above and below. The experiment was successful, and improvements in technique for future investigations are proposed. (auth)

5263 (AD-239612) STUDY OF THE DESTRUCTION OF FOOD POISONING ORGANISMS IN CANNED FOODS SUBJECTED TO IONIZING RADIATIONS. Report No. 21 (Progress) for September 10, 1959–December 9, 1959. C. W. Bohrer (National Canners Assn. Washington Research Labs., Washington, D. C.). 4p. Project No. 7-84-01-002. Contract DA-19-129-QM-445.

The inoculated pack studies using Clostridium botulinum in five food products to determine radiation sterilizing doses are completed. Incubation results have not changed since the June report. All five products have been tested for toxin production in flat cans with negative results.

Counts after 1 year of incubation on the three remaining products irradiated at room temperature have been made. These counts are given. (auth)

5264 (AECL-1120) GAMMA IRRADIATION IN CANADA. (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa). [1960]. 50p.

Six articles are collected on γ irradiation of various products and materials. The irradiations were carried out in the facilities of the AECL in connection with industrial, cooperative, and AECL Commercial Products Division studies. Separate abstracts have been prepared for each article. (T.R.H.)

5265 (AECL-1120(p.5-8)) DOSIMETRY AND RADIATION FACILITIES. K. F. MacQueen (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa).

Published in Can. Agr. Eng. 1, No. 1 (1959) Jan.

Dose measurement and irradiation facilities for Co^{60} γ rays are discussed. General considerations in dosimetry of laboratory irradiation facilities and production irradiation are outlined, and requirements for production dosimeters are set up. The γ irradiation facilities are briefly described, including a transfer case irradiator, spent fuel-rod facility, Gammacell 220, and proposed large-scale apparatus. (T.R.H.)

5266 (AECL-1120(p.9-13)) RADIATION PRESERVATION OF FOODS—AN IMPORTANT PEACEFUL APPLICATION OF ATOMIC ENERGY. C. H. Hetherington and K. F. MacQueen (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa).

Published in Agr. Inst. Rev., (1958) May-June.

The food radiosterilization programs of the US, Britain, and Canada are outlined, and results are briefly summarized. The possible applications of radiation preservation are reviewed, including pasteurization, insect control, and inhibition of sprouting. Effects of irradiation on flavor, texture, wholesomeness, and safety of foods are also discussed. (T.R.H.)

5267 (AECL-1120(p.14-34)) GAMMA RADIATION OF POTATOES.

A detailed report is given of a study of potato preservation by γ irradiation. Tubers of the Netted Gem and Katahdin varieties were given treatments of 0, 8.5, 11, and 15 krep before storage at 40 and 68°F for 11 months. At various intervals data were taken on storage and culinary properties, ascorbic acid, reducing sugars, sucrose, and starch. With 8.5 krep, sprouting was inhibited in all cases. For both varieties storage temperature and time affected the sugar, sucrose, starch, and ascorbic acid more than irradiation. Varietal differences were more pronounced than irradiation effects, and culinary properties varied more from tuber to tuber than from irradiation. (T.R.H.)

5268 (AECL-1120(p.35.9)) THE EFFECT OF IRRADIATION ON THE DEVELOPMENT OF STORAGE DISORDERS OF APPLES. W. R. Phillips, P. A. Poapst (Canada. Dept. of Agriculture. Plant Research Inst., Ottawa) and K. F. MacQueen (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa).

Presented at the International Institute of Refrigeration, Copenhagen Conference, August 1959.

A study was made of the effects of seed development on the storage behavior of apples. A preliminary irradiation revealed that 8500 to 225,000 rad reduced the percentage of seed germination from 78% in controls to 44%. A maximum dose of 425,000 rad completely suppressed germination. In the first experiment (irradiations of 8500, 85,000, and 425,000 rad), tissue destruction and higher soluble pectate readings resulted. Seed activity was suppressed and core flush reduced. A second experiment to confirm these results is also described. (T.R.H.)

5269 (AECL-1120(p.40-3) EFFECTS OF SODIUM SORBATE AND ASCORBIC ACID ON ATTEMPTED GAMMA RADIATION PASTEURIZATION OF APPLE JUICE. E. A. Asselbergs, W. E. Ferguson, and K. F. MacQueen (Canada. Dept. of Agriculture. Experimental Farms Service, Ottawa; Canada. Dept. of Agriculture. Science Service, Ottawa; and Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa).

Published in Food Technol. 12, No. 3 (1958).

A study was made to see if low radiation dosages will inactivate Acetobacter and thus extend keeping time of fresh juice at room temperature. Samples were irradiated for 2.5 and 9 hr at 69,000 rep/hr and stored at 70°F At regular intervals data were taken on flavor, color, viscosity, pectinolytic enzyme activity, acidity, pH, ascorbic acid, and microbial content. It was concluded that 621,000 rep does not produce sterile juice. After 621,000 rep in the presence of 0.05% sodium sorbate and ascorbic acid (75 mg/100 ml), the juice can be kept at room temperature for 13 days without development of microorganisms. However, alterations in flavor, viscosity, and color seriously reduce the quality and acceptability. (T.R.H.)

5270 (AECL-1120(p.44-50)) A COBALT-60 IRRADIATION FACILITY. F. G. Rice and W. D. Smythe (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Published in Ind. and Eng. Chem. 52 (1960) May.

A γ irradiation facility is described which delivers up to 1.9×10^6 r/hr in the center of a 220-cu in. chamber. The dose is delivered by 20,000 c of Co^{60}. Total weight is 7600 lb. The source is cylindrical, and the sample chamber is part of a drawer movable within the source cage. A Gammacell 220 apparatus is depicted. (T.R.H.)

5271 (ARF-1167-3) FEASIBILITY STUDY OF A NEW MASS FLOW SYSTEM. Quarterly Report No. 1 Covering the Period from June 1 to September 1, 1960. G. M. Burgwald (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Sept. 21, 1960. 29p. Contract AT(11-1)-578, Project Agreement No. 5. OTS.

With this is bound: QUARTERLY REPORT NO. 1 FOR PERIOD FROM JULY 15 TO SEPTEMBER 1, 1960. William K. Genthe (Badger Meter Mfg. Co., Milwaukee).

A mass flow measurement technique is described which has the capability of measuring homogeneous flow, slurries, highly corrosive fluids, and multiphase fluids. The device features ruggedness and reliability and has the ability to measure external to the flow. In the proposed system, the fluid is made to pass through a U-shaped tube wherein measurements of the angular momentum and density yield mass flow directly. As the fluid traverses the 180° bend, a radial force is generated, which can be measured with a force transducer. Density is determined by measurement of the radiation absorption in the fluid. (W.D.M.)

5272 (NP-9587) LONG TERM FEEDING OF IRRADIATED POTATOES. Final Report, Part 1. B. E. Kline, H. von Elbe, and J. J. Birdsall (Wisconsin Alumni Research Foundation, Madison). Nov. 1960. 37p. Contract DA-49-007-MD712.

A study was initiated in May 1958 to evaluate the effects of irradiated potatoes on the growth and reproduction of albino rats. The study has been completed with the exception of histopathology. Data are presented on growth, reproduction, and hematological effects. (auth)

5273 (NP-9588) A LONG RANGE INVESTIGATION OF THE NUTRITION PROPERTIES OF IRRADIATED FOODS. Investigations to Determine the Mechanism for Production of the Hemorrhagic Syndrome Which Develops in Male Rats that Receive Diets Containing Irradiated Beef. General Progress Report No. XVI [for] Period: March 1960 to September 1960. L. R. Richardson (Texas. Agricultural Experiment Station, College Station). 13p. Contract DA-49-007-MD-582.

Further attempts to develop a quantitative method of measuring the hemorrhagic and anti-hemorrhagic activity of irradiated and nonirradiated dried beef and soybean protein have yielded only suggestive information. The observation that high levels of vitamin A in the hemorrhagic producing diet increases the incidence of hemorrhages in male rats has been confirmed. Three of 12 rats receiving vitamin-free casein diet developed prolonged prothrombin times when coprophagy was prevented. None receiving untreated dried beef developed prolonged prothrombin times either when coprophagy was prevented or allowed. Preliminary data indicate that the level of vitamin A and K in the diet of the mothers may influence the susceptibility of the offspring to develop hemorrhages. (auth)

5274 (NP-9589) RELATIVE DESTRUCTION OF VITAMINS K AND B_6 BY GAMMA RADIATIONS (2.79×10^6 AND 5.58×10^6 RADS) AND CONVENTIONAL HEAT TREATMENT. Final Report. L. R. Richardson (Texas. Agricultural Experiment Station, College Station). Aug. 20, 1960. 19p. Contract DA-49-007-MD-582.

The vitamin K content of six foods which had been frozen, canned by conventional heat treatment, and irradiated with 2.79 and 5.58 M of gamma rays was obtained using the chick assay procedure. Foods assayed for vitamin K were asparagus, broccoli, cabbage, cauliflower, green beans, and spinach. In general, there was no difference in the vitamin K activity of foods which had been preserved by the different processes and there was essentially no loss of vitamin K in any of the foods during a storage period of 14 to 18 months. The vitamin B_6 content of six foods which had been frozen, canned by conventional heat treatment, and irradiated with 2.79 and 5.58 M of gamma rays was obtained using the growth of rats as the assay procedure. Foods assayed for vitamin B_6 were beef liver, cabbage, boned chicken, green beans, lima beans, and sweet potatoes. Destruction of vitamin B_6 was greatest in canned (heat processed) foods and least in frozen foods. Some loss occurred in irradiated foods but this loss was less than in the canned foods. All foods regardless of the method of preservation contained less vitamin B_6 after they had been stored for 6 to 18 months. The loss for different foods due to storage was variable but for general, it amounted to about 25 per cent. (auth)

5275 (NP-9625) ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS OF IRRADIATED FOODS AND APPRAISAL OF THE TOXICITY OF IRRADIATED FOODS. Progress Report No. 18 for Period March 16, 1960–September 1, 1960. V. Chalam Metta, M. S. Mameesh, P. B. Rama Rao, and B. Connor Johnson (Illinois. Univ., Urbana). 11p. Contract DA-49-007-MD 544.

Feeding of irradiated beef or vitamin K-low synthetic diets results in hypoprothrombinemia and hemorrhagic deaths of growing male rats. The female rat is markedly resistant to K deficiency. The possibility of estrogen involvement in the role of K in some unknown manner is worthy of further study. Normal reproduction was obtained in female rats maintained on synthetic K-low diets or irradiated beef diets and mated with normal males. The survival of the pups was, however, poor. None of them died of hemorrhage, and good survival has been obtained on rats fed irradiated beef diets with supplements of K only when they are maintained in an isolated room free from respiratory disease. Although it was found that the female rat is markedly resistant to vitamin K deficiency, the work with chicks suggests that both male and female chicks are equally susceptible to vitamin K deficiency. Bioassay of the chick for vitamin K indicated that there is a difference in content of vitamin K between Labco casein and Nutritional Biochemicals Corporation casein. Rats maintained on Labco casein showed normal prothrombin times, whereas, those on NBC showed elevated prothrombin times. When irradiated and non-irradiated beef, after extraction by alcohol and ether, is fed to male rats, hypoprothrombinemia results. The primary cause of hemorrhagic syndrome in the male rat fed irradiated beef is the destruction of K in beef by irradiation. (auth)

5276 (NYO-2655) THE DEVELOPMENT OF A BETA-RAY PARTICLE SIZE ANALYZER. Annual Report [for] April 1959–May 1960. Seymour Z. Lewin, Jane Connor Sheridan, and Eric J. Hewitt (Evans Research and Development Corp., New York). Oct. 10, 1960. 44p. Contract AT(30-1)-2372. OTS.

A method for the determination of particle sizes and particle size distributions was developed. The method is based upon measurements of the relative spread in replicate determinations of scattered radiation intensity as a function of viewing aperture diameter. It is shown that radiations ranging in nature from light to β particles may be utilized. The theory of the method is verified by means of measurements of the intensity of the back-scattering of C^{14} β's from monosized lead spheres under the conditions required by the theory. (auth)

5277 (NYO-9140) UTILIZATION OF RADIOACTIVE ISOTOPES IN COAL PROCESS RESEARCH. Quarterly Technical Status Report No. 6 for August 1, 1960–October 31, 1960. P. M. Yavorsky and E. Gorin (Consolidation Coal Co. Research and Development Div., Library, Penna.). Nov. 15, 1960. 16p. Contract AT(30-1)-2350).

Continued development of tritium tracer techniques for hydrocarbons used in industrial coal research is reported. The problems of tritium mobility and accurate low level assay of this weak beta emitter are being investigated. The tritium assay method of dry combustion followed by liquid scintillation counting of the product water was evaluated. It appears more accurate and dependable than the zinc fusion ion chamber method that is troublesome in low activity measurements. A small but appreciable loss of tritium from self-labeled tetralin (3.8%) and naphthalene tracers (7.5%) occurs at 380°C, due to thermally induced isotopic exchange. Exchange from aromatic positions predominates. It is possible to correct for this effect in high temperature tracer studies. (auth)

5278 (NYO-9227) EVALUATION OF THE RADIOACTIVE TRACER TECHNIQUE FOR USE IN TOOL-WEAR STUDIES. [Period covered]: February 1, 1959–June 30, 1960. N. H. Cook (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). June 1960. 70p. Contract AT(30-1)-2329. OTS.

Tungsten carbide lathe tool wear tests, carried out by conventional means and by radioisotope techniques, are compared. When the irradiated tool is used to cut under only one set of conditions, good correlation is obtained. When the irradiated tool is used under a variety of conditions, correlation is poor. If a single tool is used under

different cutting conditions, it is doubtful if differences of less than 2:1 are significant. (auth)

5279 (OTS-60-21081) EFFECT OF IONIZING RADIATION ON MEAT. (Deĭstvie Ioniziruyushchei Radiatsiĭ na Myaso). G. Egiazarov. Translated from Myasnaya Ind. S.S.S.R. 28, No. 6, 51-3(1957). 6p. (PST-Cat. No.-55). OTS.

Problems of identification of the changes induced by radiation in the physico-chemical properties of meat are discussed. Results are reported from a series of experiments on the effects of Co^{60} γ radiation on fresh meat. Samples of irradiated meat were examined for changes in pH, NH_3, H_2S, bacteriological indices, and response to benzidine test. Data are tabulated. (C.H.)

5280 (TID-11215) RADIOISOTOPES AND NUCLEAR TECHNIQUES IN THE PHARMACEUTICAL AND ALLIED INDUSTRIES. John E. Christian and William F. Bousquet (Purdue Univ., Lafayette, Ind. School of Pharmacy). June 30, 1960. 123p. Contract AT(-11-1)-737. OTS.

Results are presented from a survey of the uses, present and potential, of radioisotopes and nuclear techniques in the pharmaceutical and allied industries. It deals primarily with the technical feasibility of radioisotopic methods as applied to problems associated with pharmaceutical research, production, packaging, and control. The development of radioisotopes as tools for science and industry during the past 15 years has made possible a significant expansion of scientific methodology and technological development in American industry. Estimates of direct savings to industry through the use of radioisotopic methods range to 500 millions of dollars currently, with the expectation that this figure will be measured in billions within the current decade. Data obtained from 113 pharmaceutical companies form the basis for this report. At the present time some 32 of these companies, or 28% of those replying, indicate that they are actively engaged in a radioisotope program. Projections for the coming two years indicate that this figure will rise to 45%. An overwhelming percentage of the pharmaceutical companies using radioisotopes are doing so in biological research as tracer substances, although some development of the analytical uses has taken place. Although it is intuitive that savings result from the research uses of radioisotopes, it is not possible to describe the magnitude of such savings as a dollar amount. The study indicates further that the pharmaceutical industry is a fertile field for the application of radioisotopes as control tools for manufacturing and packaging processes. Operations carried out within this industry are particularly suited to the application of these methods as specifically related to the problems of the pharmaceutical and allied industries. (auth)

5281 (TID-11234) DEVELOPMENT OF A DOUBLE THICKNESS/DOUBLE DENSITY GAMMA GAUGE. Final Report for December 1, 1958 to December 6, 1959. (Nuclear Research Corp., Southampton, Penna.). 32p. Contract AT(30-1)-2304. OTS.

The design of a differential γ gage is described. Operational procedure is outlined and sample results are given. The γ gage system can determine the two thicknesses or the two densities of two dissimilar metals when they are placed in proximity with one another. Recommendations for improvement are included. (J.R.D.)

5282 (TID-11238) IN SITU DETERMINATION OF LIQUIDS IN SOLID MATRICES. Quarterly Progress Report No. 1. A Continuation of STUDY OF THE INDUSTRIAL POTENTIAL OF RADIOISOTOPE METHODS IN THE PHARMACEUTICAL INDUSTRY. (Purdue Univ., Lafayette, Ind. [School of Pharmacy]). Nov. 28, 1960. 4p. Contract AT(11-1)-737. OTS.

A study was initiated to investigate a rapid method for determining the moisture content of solid matrices for the pharmaceutical industry. Various radioisotopic methods were surveyed. (W.L.H.)

5283 (TID-11239) THE APPLICATIONS OF ISOTOPES TO INDUSTRIAL PROBLEMS. Progress Report Letter No. 20 for the Period October 18 to November 16, 1960. Foster F. Rieke (Chicago. Univ. Labs. for Applied Science). Nov. 18, 1960. 6p. Contract AT(11-1)-712. (LAS-L-P161-20).

Work was continued on wear and lubrication studies of piston rings by the use of radioisotopes. Work is also reported in the determination of density and moisture content of coal in storage. (W.L.H.)

5284 (TID-11252) RADIOACTIVE TRACER TECHNIQUES FOR DETECTING AND MEASURING DETERGENT RESIDUE ON WASHED FOODS AND EVALUATION OF FOOD WASHING PRACTICES. Progress Report. (National Canners Assn. Western Research Lab., Berkeley, Calif.). Nov. 1960. 48p. Contract AT(04-3)-296. OTS.

Progress is reported in studies in which radioactive detergents and tracer techniques were used for detecting and measuring detergent residue on foods washed under varied experimental conditions. Radiochemistry techniques have demonstrated the unreliability of other methods for measuring the concentration of detergent in food wash waters as a residue on the washed foods. Data are included on conditions affecting deposition and removal of detergent residue resulting from the washing of vegetables, and a detailed study of bound detergent in asparagus tissue is presented. (C.H.)

5285 (AEC-tr-4283) THE USE OF RADIOACTIVE ISOTOPES. (Die Verwendung Radioaktiver Isotope). Translated from an unidentified German report, [1960]. 11p. JCL.

The amounts of radioisotopes used and produced in the world are reviewed and compared with that of the German Federal Republic. Import-export figures, amounts used, and users are cited to show a lag in this area. (T.R.H.)

5286 (CEA-tr-R-910) CONTRÔLE RADIOMÉTRIQUE DU NIVEAU DES MATÉRIAUX CHARGÉS DANS UN HAUT FOURNEAU. (Radiometric Control of the Level of Material Loaded in a Blast Furnace). I. G. Polovtsev (Polovtchenko), G. A. Vasil'ev (Vassiliev), V. N. Afanas'ev (Afanasiev), V. N. Uzlyuk (Uzliuk), and A. L. Berin. Translated into French from Stal' 19, 204-5(1959). 9p.

A radiometric system for preventing overloading in blast furnaces and regulating the charge level is described. The system operates on the radiography principle. Two Co^{60} sources (500 mc) are installed in openings opposite each other near the top of the furnace. Counters are then arranged with respect to the sources so that they can be moved up and down in cooled tubes. Thus the load-level can be determined, or the progress of a charge through the furnace can be followed. (T.R.H.)

5287 (NP-tr-524) THE EFFECT OF RADIATION ON FOODSTUFFS. 5th REPORT: EFFECT ON CORN, FLOUR, BAKERY PRODUCTS AND CARBOHYDRATES. Rudolf Kohn and Hans Lück. Translated by A. Schoenfeld (U.K.A.E.A. Atomic Energy Research Establishment) from Deut. Lebensm.-Rundschau 56, 1-6(1960). 17p. JCL.

Data are summarized from studies on the effects of

radiation on storage life, flavor, and nutritional properties of corn, flour, carbohydrates, and bakery products. (C.H.)

5288 (NP-tr-526) THE PRESENT STATUS OF THE PROBLEM OF USING RADIOACTIVE ISOTOPES AND RADIATIONS IN THE PETROLEUM REFINING INDUSTRY. (Sovremennoye Sostoyaniye Problemy Ispol'zovaniya Radioaktivnykh Izotopov i Izlucheniy v Neftepererabotke). Yu. S. Zaslavskiĭ (Zaslavskiy). Translated from Khim. i Tekhnol. Topliv i Masel No. 1, 5-15(1959). 18p. OTS.

A brief review is presented of applications of radioactive isotopes and radiations in the petroleum refining industry. Radiation sources designed for the use of the petroleum and chemical industries are described and illustrated. Shielding problems are discussed. Applications reviewed include intensive radiation-chemical investigations in the fields of petroleum refining, petroleum chemical synthesis, polymerization processes, oxidation processes, the halogenation and cracking of organic compounds, and the radiation chemistry of polymers. The use of radiation sources in instruments for telemetering, recording or controlling of levels, separation boundaries of media, densities of liquids and mixtures, analysis of chemical composition of products, the control of consistent pumping of petroleum products, the evaluation of properties of fuel-oil materials, wear tests on machinery, the corrosive properties of lubricants, the effect of admixtures to lubricants, the formation of deposits in internal combustion engines, and the use of C^{14} labeled fuels in studies of the effects of chemical and fractional composition on the formation of deposits, scale formation, and the distribution of the fuel mixture over engine cylinders are also reviewed. (C.H.)

5289 THE APPLICATION OF RADIOISOTOPES IN HYDROLOGY. IV. MEASUREMENT AND DETECTION OF THE RADIOACTIVE TRACER I^{131}. PART 1. H. Moser and W. Rauert (Forschungsstelle für Radiohydrometrie, Munich). Atomkernenergie 5, 419-25(1960) Nov. (In German)

The experiences and considerations reported have resulted from hydrological measurements of ground and surface water in which I^{131} was used as tracer. The discussion of the relation between injection and detection shows that reliable indications for an optimum determination can be obtained only by preliminary experiments. The two methods of detection are described and compared. The sampling method is described. In this method water samples are taken with subsequent extraction and measurement of the tracer. A detection sensitivity of 10^{-10} $\mu c/cm^3$ is possible by the sampling method. (tr-auth)

5290 A LONG-TERM FEEDING STUDY OF IRRADIATED FOODS USING RATS AS EXPERIMENTAL ANIMALS. L. R. Richardson, S. J. Ritchey, and R. H. Rigdon (Texas Agricultural Experimental Station, College Station) and Univ. of Texas Medical Branch, Galveston). Federation Proc. 19, 1023-7(1960) Dec.

In one series of tests, four generations of rats received an irradiated synthetic diet. Growth and reproduction performance of the animals receiving the irradiated diet were essentially equal to those of animals receiving the nonirradiated or control diet. In a second series of tests, four generations of rats received nine different combinations of control and irradiated green beans and boned chicken. Each food was irradiated at dose levels of zero, 2.79, and 5.58 megarads. No significant differences in gain in weight at 12 weeks occurred in the parent, F_1, and F_2 generations for any combination of the irradiated and control foods. Likewise, irradiation of the food did not effect the hematologic or histopathologic picture or the weights of heart, lungs, liver, spleen, kidneys, or testes. A few blind young were weaned from mothers receiving both the irradiated and control foods. Blindness occurred also in groups of young from mothers receiving synthetic diets which had not been irradiated. In some cases, the incidence of blindness was higher in the young from these diets than it was from the irradiated. The over-all data show that the blindness which occurred was not due to the irradiated food. (auth)

5291 EFFECT OF IRRADIATED MEAT UPON GROWTH AND REPRODUCTION OF DOGS. C. M. McCay and G. L. Rumsey (Cornell Univ., Ithaca, N. Y.). Federation Proc. 19, 1027-30(1960) Dec.

Data are summarized from a series of studies on the effect of feeding irradiated meats on the growth rate, health, and reproductive performance of dogs over a three-year period. The meats studied included beef, pork, tuna fish, and chicken stew. (C.H.)

5292 HEART LESIONS IN MICE INDUCED BY FEEDINGS IRRADIATED FOODS. Harry Monsen (Univ. of Illinois, Coll. of Medicine, Chicago). Federation Proc. 19, 1031-4(1960) Dec.

A diet composed of irradiated pork loin, chicken, evaporated milk, blanched carrots, and white potatoes was fed to mice of the strong A and Cb strains. In the Cb group of mice, 17.5% of all animals on the irradiated diet died or were killed because of rupture and/or dilatation of the left auricle of the heart. Only 2% of the strong A mice developed similar lesions. No heart lesions have ever been observed in litter mate control mice of both strains receiving an identically composed nonirradiated diet. The feeding of irradiated evaporated milk only to animals of the Cb strain resulted in the death of 60 to 80% of the mice due to heart lesions. (auth)

5293 CARBONYL COMPOUNDS AS INHIBITORS OF LIPID METABOLISM AND THEIR SIGNIFICANCE IN IRRADIATED FOODS. Kenneth J. Monty (Johns Hopkins Univ., Baltimore). Federation Proc. 19, 1034-7(1960) Dec.

Results are reported from an evaluation of the physiological effects of the ingestion of fat soluble carbonyl compounds formed in irradiated meats. From the results of tracer studies on the metabolism of corn oil in rats, it was concluded that carbonyl compounds affect the absorption as well as the digestion of fats. (C.H.)

5294 VITAMIN K NUTRITION AND IRRADIATION STERILIZATION. B. Connor Johnson, M. S. Mameesh, V. C. Metta, and P. B. Rama Rao (Univ. of Illinois, Urbana). Federation Proc. 19, 1038-44(1960) Dec.

From the experimental data presented it can be seen that the rat does have a dietary requirement for vitamin K which on some diets is partially supplied by coprophagy. This requirement is much greater for the male than for the female; for the male it approximates 0.1 μg of vitamin K per g of ration. Pork and beef are poor sources of vitamin K, and irradiation further lowers the available vitamin K level, thus resulting in severe vitamin K deficiency when fed as the sole source of vitamin K in the ration of the male rat. This situation is entirely analogous to that of many other vitamins which are destroyed or decreased in level by processing methods, and it can be readily counteracted by providing a mixed diet containing other sources of the vitamin in question, or by supplementing the diet. (auth)

5295 INFLUENCE OF AGE, SEX, STRAIN OF RAT AND FAT SOLUBLE VITAMINS ON HEMORRHAGIC SYNDROMES IN RATS FED IRRADIATED BEEF. Susan J.

Mellette and Louis A. Leone (Medical Coll. of Virginia, Richmond). Federation Proc. 19, 1045-9(1960) Dec.

It has been shown by a number of investigators working on this problem that the incidence of a hemorrhagic syndrome associated with the feeding of irradiated beef diets to the rat is influenced by the age, sex, and strain of rat employed. Administration of male hormones or castration of female rats results in an increased susceptibility to hypoprothrombinemia and hemorrhage; whereas the converse is true for the administration of estrogenic hormones or castration of the male animal. Changes in the composition of the diet, particularly the addition of large amounts of vitamins A and E, may increase mortality and depress prothrombin levels. Supplemental bile acids or an emulsifying agent have a beneficial effect, probably secondary to improved absorption of vitamin K. Irradiation of the beef in the diets which were studied is not a prerequisite for the development of low levels of prothrombin in the male rat. Hypoprothrombinemia may occur in animals fed similar diets containing nonirradiated beef and even in animals receiving a commercial stock laboratory chow. (auth)

5296 TISSUE MODIFICATION AND IRRADIATED FOOD INGESTION. Ian J. Tinsley, Edward C. Bubl, and Jesse F. Bone (Oregon State Coll., Corvallis). Federation Proc. 19, 1049-52(1960) Dec.

Long-term feeding studies were carried out to evaluate the wholesomeness of irradiated organ meats, pork, jam, carrots, peaches, and flour. In addition to the visible physiological function data, an extensive gross and histopathological examination was carried out on the tissues of the dead or sacrificed animals. The pathological findings are summarized. Data are included on tumor incidence and changes in enzyme activity following the ingestion of irradiated foods. (C.H.)

5297 HUMAN FEEDING STUDIES WITH IRRADIATED FOODS. I. C. Plough, E. L. Bierman, L. M. Levy, and N. F. Witt (U. S. Army Medical and Nutrition Lab., Denver and Univ. of Colorado, Boulder). Federation Proc. 19, 1052-4(1960) Dec.

A group of young men consumed diets consisting of up to 100% irradiated foods for periods of 15 days in a series of seven tests. Some 54 different irradiated foods were either frozen or stored at room temperature, after irradiation. There was no evidence of toxic effects from eating irradiated foods in any of the men, either by clinical examination or by laboratory tests. (auth)

5298 A SUMMARY OF THE WHOLESOMENESS OF GAMMA-IRRADIATED FOODS. Merrill S. Read (Virginia Polytechnic Inst., Blacksburg and U. S. Army Medical Research and Nutrition Lab., Denver). Federation Proc. 19, 1055-9(1960) Dec.

Chronic toxicity tests employing 22 radiation-sterilized food products fed to four species of experimental animals are now in progress. Although these tests have not been completed, preliminary analysis of the data indicates that 20 of these foods are not grossly toxic to at least one species of animal (rats or dogs). Nutritional evaluation of purified macronutrients suggests that no significant biological effect will result from consumption of the irradiated products. Nevertheless, a radiation-induced improvement in the utilization of soybean protein has been reported for the rat. Conversely, interesting decreases in the digestibility of irradiated starch and corn oil have also been observed. Consumption by rats of a mixed diet of many radiation processed foods causes a decrease in rat growth as radiation level increases. Oral daily supplementation with both thiamine and pyridoxine eliminates the difference in growth; supplementation with either vitamin alone provides only partial protection. When coupled with the growth data, enzymatic indices employed to evaluate the extent of vitamin deficiencies suggest that the pyridoxine deficiency may be the more limiting factor in consumption of composite irradiated diets by rats. (auth)

ISOTOPE SEPARATION

5299 (AEC-tr-4171) THE SEPARATION OF URANIUM ISOTOPES. (Separazione Degli Isotopi dell'Uranio). P. Caldirola and R. Fiocchi. (Italy. Comitato Nazionale per le Ricerche Nucleari, Centro di Studi Nucleari, Ispra). Translated from report CNI-24. 1959. 124p. OTS.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 510.

5300 (AEC-tr-4349) ON THE SEPARATION POTENTIAL OF THERMALLY DRIVEN COUNTERCURRENT GAS CENTRIFUGES. II. ASYMMETRICAL SEPARATION PROCESS. W. Bulang, W. Groth, I. Jordan, W. Kolbe, E. Nann, and K. H. Welge. Translated by Kurth H. Quasebarth from Z. physik. Chem. (Frankfurt) (N. S.) 24, 249-64 (1960). 25p. JCL.

Issued by the Univ. of Virginia, Research Labs. for Engineering Sciences as report EP-4422-117-60U.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 20512.

5301 SEPARATION FACTOR OF TRITIATED WATER FRACTIONAL IN DISTILLATION. P. Avinur and A. Nir (Weizmann Inst. of Science, Rehovoth, Israel). Nature 188, 652(1960) Nov. 19.

Previous values obtained for the vapor pressure of tritiated water based on enrichment experiments in fractionating columns are reevaluated. The value obtained was 1.055 ± 0.002 at 260 mm Hg. The main source of error is assumed to be the error in measuring the length of the column and the transfer coefficient for vapor-liquid interface. These values could not be measured directly and were calculated using the enrichment values of tritiated oxygen in the same system. (M.C.G.)

MATHEMATICS AND COMPUTERS

5302 (NAA-SR-5178) NUMERICAL SOLUTION OF QUASI-LINEAR EQUATIONS. E. R. Cohen and H. P. Flatt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 1, 1960. 22p. Contract AT-11-1-GEN-8. OTS.

Two different approaches, based on mean-value theorems, to the problem of numerically integrating the quasi-linear equation $dy/dx = \alpha y + F(x,y)$ are discussed. Applications of AIREK and modified AIREK code equations to the solution of similar quasi-linear equations are discussed. (C.J.G.)

5303 (NDA-2563-9) SAFETY III CODE. J. Certaine, W. Guber, and H. Mechanic (Nuclear Development Corp. of America, White Plains, N. Y.). Aug. 15, 1958. 18p. For Atomic Power Development Associates, Inc.

The Safety III code is used to solve heat balance and neutron dynamic equations. A description of the mathematical procedure of the code is given along with solutions to example test problems. (C.J.G.)

5304 (SCR-99A) SANDIA CORPORATION PAPERS ON RELIABILITY AND RELATED TOPICS. L. W. New-

house, comp. (Sandia Corp., Albuquerque, N. Mex.). June 1959. First Revision Oct. 1960. 16p. OTS.

A listing of 95 Sandia Corporation papers relating to product reliability is presented. Most of the listed publications were made available to the public under the Civilian Applications Program of the AEC. Information on how to obtain the papers is included. (J.R.D.)

5305 (SCTM-170-56(51)) A DISCUSSION OF THE ANALYSIS OF 2 × 2 TABLES. J. M. Wiesen, D. B. Owen, and G. P. Steck (Sandia Corp., Albuquerque, N. Mex.). Oct. 24, 1956. Second Reprinting Mar. 15, 1960. 60p. OTS.

Aspects of testing the significance of 2 × 2 contingency tables are discussed. The principle application is in testing the equality of two proportions. Tables are presented for making the suggested test. (auth)

5306 (TID-11191) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. MATHEMATICAL METHODS. PART IV. SWITCHING CIRCUIT THEORY. PART V. ILLIAC USE AND OPERATION. PART VI. IBM 650 USE AND OPERATION. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). June 1960. 44p. OTS.

5307 (TID-11192) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. MATHEMATICAL METHODS. PART IV. ILLIAC USE AND OPERATION. PART V. IBM 650 USE AND OPERATION. PART VI. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). July 1960. 44p. OTS.

Work on logical design, control design, basic circuits, core storage unit, auxiliary storage, and control design in the high-speed computer program is summarized. In the circuit research program work on flow-gating send-driver, speed tests of flow-flops, low-impedance two-wire system, and switching theory is discussed briefly. Illiac and IBM-650 use and operation and general laboratory information are summarized. (W.D.M.)

5308 A METHOD OF COMPUTING BIVARIATE NORMAL PROBABILITIES WITH AN APPLICATION TO HANDLING ERRORS IN TESTING AND MEASURING. D. B. Owen and J. M. Wiesen (Sandia Corp., Albuquerque, N. Mex.). Bell System Tech. J. 38, No. 2, 20p.(1959) Mar. (SCR-61)

Charts and formulas are presented from which bivariate normal probabilities may be computed. Formulas involving the bivariate normal are given for the solution of a problem of handling errors in testing and measuring. These formulas include, in addition to previously published cases, two new cases. In one, the product is not necessarily centered relative to two-sided specification limits; in the other, one-sided specification limits are considered. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

5309 (CF-60-8-48) ORNL FUEL CYCLE PROGRESS REPORT FOR PERIOD MAY 15, 1960–JULY 15, 1960. D. E. Ferguson (Oak Ridge National Lab., Tenn.). Aug. 10, 1960. 5p. OTS.

Oxide samples prepared by the sol-gel technique were vibratory compacted to 87% of theoretical density for pure ThO_2 and 83% for mixed thorium-uranium oxides. These oxides were prepared from a sol by slow drying and 1200°C calcination. The density of oxide vibratory compacted into a seven-tube bundle, 86% of theoretical, was no different from that obtained in single tubes. The material of construction of the fuel tube (stainless steel, Zircaloy, or aluminum) had little effect on the density that was obtained by vibratory compaction. Samples of $UO_{2.000}$ have been prepared by precipitation from a fused fluoride melt. This material is being used to determine physical constants for UO_2. (auth)

5310 (NP-9340(Vol. I)(Sect. II)) PREPARATION AND PROPERTIES OF METALLIC AND OXIDE FUELS. Steinar Aas (Norway. Institutt for Atomenergi, Kjeller). Section II of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 47p.

The crystal structure, physical properties, mechanical properties, deformation processes, preferred orientations, alloys, compatibility and diffusion, thermal cycling growth, irradiation effects, and corrosion properties of metallic uranium are briefly reviewed. The physical properties of uranium oxide are discussed in terms of crystal structure, melting point, mechanical strength, vapor pressure, thermal conductivity, thermal expansion, oxidation, corrosion, compatibility, diffusion and fission gas release, and fabricability. (W.D.M.)

5311 (NP-9340(Vol. I)(Sect. V)) PRODUCTION AND PROPERTIES OF ZIRCONIUM CLADDING MATERIAL. D. E. Thomas (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Section V of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 36p.

Properties of cladding materials, production of zirconium, working of zirconium alloy to stock for fuel-element components, joining, physical properties of Zircaloy-2, corrosion properties, and mechanical properties are discussed in some detail. (W.D.M.)

5312 (NP-9340(Vol. I)(Sect. VI)) MANUFACTURING AND PROPERTIES OF NUCLEAR FUEL ELEMENTS. D. E. Thomas (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Section VI of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 50p.

Fuel-element configurations, feasible material combinations, construction, and properties are treated in detail. The corrosion, irradiation, and mechanical behavior of fuel elements, and the way in which these properties are related to fabrication procedures, are considered. (W.D.M.)

5313 (NP-9606) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS, SEPTEMBER 1960. M. J. Wahll, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). 193p.

A listing of selected, acquired articles, reports, and papers concerning Ti, Be, B, Mo, Nb, Ta, Cr, W, V, Re, steel, and stainless steel is presented. Author and subject indexes are included. (W.L.H.)

5314 (NP-9619) THE EFFECT OF ARC PLASMA DEPOSITION ON THE STABILITY OF NON-METALLIC MATERIALS. Bi-Monthly Report No. 4 Covering period September–October 1960. E. B. Kramer and M. A. Levinstein (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Dec. 3, 1960. 28p. Contract NOas 60-6076-C. (DM-60-274)

The oxides of Al, Zr, Cr, Ce, and Hf were flame sprayed using a plasma jet metallizing torch. Compressive strengths are reported for Al_2O_3 and ZrO_2. Photographs and photomicrographs are shown for all materials. (auth)

5315 (ORNL-3017(p.50-1)) ELECTRON MICROSCOPE STUDIES. T. S. Noggle and J. O. Stiegler (Oak Ridge National Lab., Tenn.).

The results of an electron microscope study of fission fragment tracks in thin films of UO_2 are summarized. Two different replica techniques employed by the group during the past year are described; and an explanation of the mechanism of the replica stripping behavior of Victawet, a water-soluble parting material, is presented. (auth)

5316 (ORNL-3017(p.52-5)) SURFACE BOMBARDMENT OF SOLIDS. A. L. Southern, D. R. Burrowbridge, et al. (Oak Ridge National Lab., Tenn.).

A beam of Ar^+ ions has been used to bombard the surface of type 304 stainless steel. The resultant sputtering was studied by measuring the loss of mass of the metal and the results expressed as a "sputtering ratio," $S = (N_{SA}/N_{Ar^+})$, where N_{SA} is the number of particles removed and N_{Ar^+} is the number of incident Ar^+ ions during the experiment. This ratio has been determined at ion energies from 1 to 5 kev. At 3 kev the value is 2.3 ± 0.1 atoms/ion. The r-f ion source-electrostatic lens combination used was studied, and it was found that 95% of the ions impinging on the target were within 100 ev of the expected energy. (auth)

5317 (ORNL-3017(p.56-7)) BRITTLE FRACTURE OF METALS. J. C. Wilson (Oak Ridge National Lab., Tenn.).

Further purification of zone-refined and vacuum-melted iron has been carried out. Solid-state electrolysis, solid-state zone refining (between α and γ ranges), electron-beam melting, and heat treatments in high vacuum were used. Physical property measurements showed some success for each of these methods. (W.L.H.)

5318 (SCNC-296) QUARTERLY TECHNICAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1959. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). May 1959. Decl. Nov. 2, 1960. 32p. Contract AT-30-[1]-GEN-366. OTS.

Additional data were obtained on sintered UO_2 pellet assemblies which were hot isostatically pressed. The effects of composition and particle size on the oxygen and nitrogen contents of sintered Y–U alloys were investigated. Variation of Vickers hardness values of Y–U alloys with temperature was determined. Thermal cycling, thermal expansion, and corrosion tests were performed on Y–U alloys. Samples of $UO_2-Y_2O_3$, $UO_2-Nb_2O_5$, and UO_2-CeO_2 were prepared for thermal conductivity tests. Results of measurements on $UO_2-Y_2O_3$ samples are presented. The preparation of ThO_2-UO_2 and $ThO_2-UO_2-Y_2O_3$ for thermal conductivity tests are reported. (W.L.H.)

5319 (TID-11224) INFORMAL LETTER PROGRESS REPORT [FOR] NOVEMBER 1960. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). 7p. OTS.

Fabrication of U–Y alloys for irradiation experiments is reported. Results are reported on samples of UC produced from the reaction of $UF_4 + Si + C$ at 1550°C. Test runs were made under argon in the small induction-heated reactor with $UF_4 + Si + C$ mixtures to test its performance before introducing any UF_6. (W.L.H.)

5320 (UCRL-6187) OXIDATION PROTECTION OF COLUMBIUM BASE ALLOYS. John W. Cox, Richard W. Werner, and Joe L. Morris (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 14, 1960. 12p. Contract W-7405-eng-48. OTS.

The application of pack diffused type coatings for the oxidation protection of niobium alloys is discussed. A program to evaluate coating processes for niobium alloys is discussed. (C.J.G.)

5321 (AEC-tr-4373) DIRECT DETERMINATION OF AVERAGE PARTICLE SIZE IN A MICROSCOPIC PREPARATION WITH AN ELECTRICAL POINT COUNTER EQUIPPED WITH AN EYEPIECE ATTACHMENT. Gunther Schneider. Translated from Z. Metallk. 51, 414-20(1960). 13p. JCL.

After a review of previously used methods of measurement, it is shown how point counters can be used to determine microscopic particle size, using as an example the Eltinor electrical integrating system, which works on a point-measuring principle. Determination of particle size and proportional composition, as well as simultaneous qualitative and quantitative particle-size classification in the microscopic range can be performed in parallel in one differentiated operation for one or more components. Besides the methodological procedures proper, variability of measurement and representativeness of the resultant mean values for the sample range investigated are discussed. The nomographic aids cited serve for rapid evaluation of the measurements themselves, within the framework of calculations necessary to determine the representativeness of such values for the whole sample area or for relatively large portions thereof. An appropriate alignment chart was derived and constructed in the form of a two-part chart, which is simple to set up and easy to adapt for different size ranges. (auth)

5322 (NP-tr-529) NEW METHOD OF PREPARING METAL ALLOYS. (Noviy Sposob Prigotovleniya Metallicheskikh Splavov). G. I. Pogodin-Alekseev and V. V. Zaboleev-Zotov (Zaboleyev-Zotov). Translated from Liteĭnoe Proizvodstvo No. 7, 25-6(1958). 7p. OTS.

A method for preparing dispersed alloys by use of ultrasonics is described. The equipment is described in detail. (W.L.H.)

5323 (NP-tr-531) [METALLURGY]. Translation of Selected Articles from Silikáty 3, 139-53; 192-201(1959). 46p. OTS.

The sintering of Al_2O_3 was investigated. It was found that the sintering is strongly influenced by the thermal and mechanical treatment, which makes it possible to control the sequence of forming various types of Al_2O_3 differing from each other with respect to sintering capacity. The effect of admixtures on the sintering process was studied. A general review of composition, properties, structure, and use of cermets is presented. The properties of carbide and oxide cermets are discussed. (W.L.H.)

5324 CONSTRICTED-ARC PROCESS CUTS METALS UNDER WATER. C. H. Wodtke (Oak Ridge National Lab., Tenn.). Metal Progr. 78, No. 6, 91-3(1960) Dec.

Constricted-arc cutting with torches of special design was adapted at Oak Ridge National Laboratory for underwater operation and is being used successfully in the maintenance of nuclear reactors. Cutting is rapid and because the torch and work are completely submerged, spatter is confined and release of radioactivity to the air is reduced to a safe level. (auth)

5325 SILICON CARBIDE CLAD GRAPHITE MATRIX FUEL ELEMENTS. K. M. Taylor and C. H. McMurtry (Carborundum Co., Niagara Falls, N. Y.). p.318-23 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

A spherical graphite matrix element fueled with uranium

dicarbide and clad with an impermeable layer of silicon carbide is described for use in pebble bed gas-cooled reactors. The following topics are discussed: fabrication techniques, cladding permeability tests, oxidation resistance, carbon density, crushing strength, impact resistance, fuel distribution, self-welding characteristics, and resistance to thermal cycling. (auth)

5326 GRAPHITE AS A FUEL MATRIX. William C. Riley (Battelle Memorial Inst., Columbus, Ohio). p.324-35 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Recent work on fabrication development, laboratory evaluation, and reactor evaluation of fueled graphite is reviewed. Methods of preparing fueled graphites are discussed with respect to possible differences in reactor performance and processing costs. Geometries and fuel loadings that have been achieved are mentioned. Data are given on variation in physical properties with fuel content. The experimental evidence presented indicates that neutron plus fission fragment irradiation at temperatures of about 1300°F tends to cause the matrix structure to change from graphite to disordered carbon. With respect to dimensional distortion, the individual effects of fission fragment and neutron irradiation at about 1300°F were separated. Each appears to cause contraction. A relationship between dimensional distortion and the number of fission fragments attenuated in the matrix is suggested. Fission product release from a number of types of fueled graphites are reported. Results of both laboratory heat-treatment studies following low-temperature, low-exposure irradiation, and high-temperature in-pile studies indicated that the release of fission gases was the order of at least 1 per cent of those calculated to be present. Methods for improving fission product retention are discussed. The experimental evidence presented indicates that surface coatings, impervious graphite, and impervious cladding for fuel particles have some potential. Available data on chemical reactions between fuel compounds and the graphite matrix are discussed briefly. Recommendations for future developmental work are included. Emphasis should be placed on improved fission product retention and studies of radiation effects at high exposures. (auth)

Corrosion

5327 (AAEC/E-52) INITIAL RESULTS ON THE COMPATIBILITY OF AUSTENITIC STAINLESS-STEEL WITH CARBON-DIOXIDE. A. Draycott and R. Smith (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mar. 1960. Re-issued Aug. 1960. 29p.

An experiment was carried out on the oxidation behavior of an 18–8–Ti stabilized steel in CO_2 at 550 to 700°C under varying conditions of surface preparation, pressure, velocity, and impurity content of the gas. The rate of oxidation was followed by measuring the weight increase of specimens as a function of time of exposure in tests of up to 2500-hr duration. Supporting information on the nature of the oxidation process was obtained from metallographic studies and x-ray diffraction. It was found that work-hardened surfaces oxidized at a much lower rate than etched surfaces. In the case of work-hardened surfaces, a protective film of Cr_2O_3 formed which persisted throughout the duration of the tests. On etched surfaces, rapid oxidation occurred to give a nonprotective multi-layer scale. In no case studied was there any evidence of carburization. Both pressure and velocity of the gas had considerable effects on the rate of attack of the steel. This investigation showed that in the ranges of pressure and velocity investigated, the 18–8–Ti austenitic stainless-steel can be used in CO_2 at temperatures up to 675°C. (auth)

5328 (NP-9616) OXIDATION BEHAVIOR OF SOME CHROMIUM-BASE ALLOYS AT 1800 to 2000°F. Toru Yukawa, Robert Widmer, and Nicholas J. Grant [Battelle Memorial Inst., Columbus, Ohio]. [1957?]. 37p.

The behavior of a series of chromium-base alloys (95% or more chromium) with respect to their surface reaction with air was investigated. Oxidation tests were made mainly at 1800 and 2000°F. Weight increase curves of the different materials were established and the structure of the surfaces of the specimens were subsequently examined by metallographic and x-ray methods. A partial explanation for the mechanism of the reactions is offered. (auth)

5329 (WADD-TR-60-115) CORROSION OF SUPER-ALLOYS BY SELECTED FUSED SALTS. [Period] covered: March 15, 1959–February 15, 1960. A. Moskowitz and L. Redmerski (Crucible Steel Co. of America, Pittsburgh). Feb. 15, 1960. 83p. Project No. 7312. Contract AF33 (616)-6196. (AD-237941). OTS.

Corrosion of Inconel X, Inconel 702, Rene 41, M-252, and Haynes 25 by KCl and LiF at 1600 to 1900°F was studied. Thin coatings of the salts (1.5 mg/cm^2) caused severe corrosion of the alloys in air which resulted in accelerated failures of thin sheet specimens in creep-rupture tests. Rankings for the alloys based on these tests were similar for uncoated and coated materials: Haynes 25, Rene 41, and M-252 best, Inconel 702 poorer, and Inconel X poorest. Corrosion products consist of oxides and spinels. Very little corrosion occurs without oxygen. The presence of the salt prevents the normal formation of a protective oxide film. X-ray diffraction studies showed differences between the normal oxidation products and the oxide corrosion products produced with salt present. The corrosion occurs as severe surface attack with consequent eroding away of metal, as intergranular penetration, and as internal voids formed in the alloy. All the alloys were susceptible to each of these types of corrosion. Grain boundary separation effects due to stress (2500 to 10,000 psi) were also found. (auth)

5330 SILICON AND TITANIUM DIFFUSION INTO NIOBIUM AND OXIDATION KINETICS OF THEIR ALLOYS. P. M. Arzhanyĭ, R. M. Volkova, and D. A. Prokoshkin. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 156-60(1960). Sept.-Oct.

Silicon and titanium surface diffusion produce a $NbSi_2$ phase with diffused titanium up to 5 wt. %, resulting in a hexagonal lattice structure with parameters a = 4.779 and c = 6.493 kX. The oxidation kinetics of niobium with silicon and titanium show an oxidation film of rutile and tridymite. The oxidation activation energy is 3660 cal/mol. It is shown that at 1200°C, a niobium surface saturated with titanium and silicon oxidizes about 1.5 times slower than a niobium surface saturated with silicon. The resulting film is thin, strong, and well bonded to the niobium. (R.V.J.)

5331 MICROTOPOGRAPHY OF OXIDE FILMS FORMED ON TANTALUM. R. E. Pawel, J. V. Cathcart, and J. J. Campbell (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc. 107, 956-60(1960) Dec.

Optical and electron microscopy were used to characterize the surface of tantalum specimens oxidized at temper-

atures ranging from 300 to 700°C. At the lower temperatures, the initial stages of oxidation were shown to consist of an aggregation of oxide platelets visible on the surface as crystallographically dependent, acicular structures extending from the grain boundaries. At higher temperatures, nodular growths were observed whose nucleation was not a grain-boundary phenomenon. Continued oxidation at temperatures of 500°C and above produced blistering and cracking of the oxide layer. The oxide platelets were shown to have grown during oxidation and not during cooling from the reaction temperature. At higher temperatures, both platelets and nodules served as preferred sites for blister and crack formation in the oxide and thus played an important role in the transition from the protective to the nonprotective stage of oxidation of tantalum. (auth)

5332 INHIBITION OF CORROSION OF ALUMINIUM ALLOYS. (to Atomic Energy of Canada Ltd.). British Patent 847,981. Sept. 14, 1960.

A method of inhibiting corrosion of aluminum–nickel alloys by water or aqueous solutions at 150 to 350°C which consists of adding silicic acid in amounts ranging from 100 to 1000 ppm to the solutions is given; a corrosion-resistant coating of a complex aluminum silicate is formed on the alloy surface. In this way, corrosion is reduced from the usual rate of 0.1 to 0.01 in. per year for water at 260°C and a velocity of 20 fps to 0.001 in. per year or less, which is advantageous in use of aluminum–nickel alloys as fuel rod sheath material in water-cooled reactors. This method is most effective for aluminum–nickel alloys of 0.5 to 5.0 wt. % Ni, especially those containing 0.5 to 2.5 wt. % Ni, 0.5 to 1.0 wt. % Fe, and 0.1 to 0.2 wt. % Si. The alloys may be pretreated by heating in an aqueous solution of silicic acid to 250 to 350°C for 1 to 7 days. A mixed bed resin saturated with silicic acid may be installed in a cool bypass in parallel with the circulating water system to regulate the silicic acid concentration in the water. Several examples of the corrosion reduction afforded by this method are given for both static and flowing water systems. (D.L.C.)

Fabrication

5333 (AD-229606) LEAD SHIELDING. Interim Report No. 2 [for] June 30, 1959 through June 30, 1960. (Storchheim Research and Development Corp., Woodside, N. Y.). Nov. 2, 1959. 34p. Contract NOas 59-6249-c.

The data given are those obtained for lead strip, directly rolled from Glidden 40B and 200B lead powders. Significant improvement in mechanical and physical properties developed in lead strip during this period is attributed to controlled powder feeding by use of a vibrated mechanical hopper. Stress-rupture testing is in progress and the data generally agree with the original work conducted at Metals Research & Development of Exeter, Penna. Corrosion data show powder-rolled lead to be on par if not superior to the cast-wrought product. Metallographic investigations were initiated with the general indications that room-temperature recrystallization and grain growth are inhibited in lead strip produced by the direct powder-rolling process. (auth)

5334 (AD-237665) EXPLOSIVE FORMING OF REFRACTORY METALS. Bi-Monthly Report No. 3 [for] October 31, 1959 through December 31, 1959. Richard L. Wachtell (Chromalloy Corp., White Plains, N. Y.). Jan. 1, 1960. 28p. Contract NOas-59-6205-c. With this is bound: PHYSICAL TESTS AND PHOTOMICROGRAPHY OF STRUCTURE. Roger Harvey (New York Testing Labs., Inc.). Feb. 5, 1960.

Sixty-four tests using pure molybdenum and ½% titanium alloyed molybdenum are reported. The range of temperatures used was 212 to 740°F. Synthetic mica (200 mesh) and powdered alumina (325 mesh) were tested for energy transmitting media. Explosive charges ranging in magnitude from 15% dynamite to RDX and in weights ranging from 1 to 45 g each were used in producing detonation velocities of 2000 to 8000 m/sec. (For preceding period see AD-231924.) (auth)

5335 (AD-237798) LEAD SHIELDING, APRIL 30, 1960. Interim Report No. 5 [for] June 30, 1959 through June 30, 1960. (Storchheim Research and Development Corp., Woodside, N. Y.). 15p. Contract NOas 59-6249-c.

The major effort during the period was devoted to the production of a large quantity of powder rolled lead strip that was required by the Bureau of Weapons. Certain modifications in rolling procedure, arrived at in the process of rolling these samples, were made. Owing to the effort required for the production of these samples and the fact that direct rolling parameters had been established, a considerable amount of experimental work was eliminated. Stress-rupture and tensile testing were therefore kept to a minimum. For a more complete property evaluation of the powder rolled lead strip, a heat-treating and cold reduction study was started and is now in progress. The direct rolling of a prealloyed 99% lead–1% alumina powder was also investigated. (See also AD-229606.) (auth)

5336 (AD-240069) LEAD SHIELDING. Final Report [for] June 30, 1959 through June 30, 1960. (Storchheim Research and Development Corp., Woodside, N. Y.). 67p. Contract NOas 59-6249-c.

The results of an experimental investigation of direct powder rolling as applied to the fabrication of lead strip are summarized. It was found that powder fabricated lead strip is several times as strong as the cast-wrought product, is many times as creep resistant, and possesses better corrosion resistance to concentrated sulfuric acid. Processing variables such as powder characteristics, powder feeding techniques, roll lubrication, rolling speed, cold reduction, and heat treating were investigated and related where possible to the mechanical properties of the strip. Strip properties investigated included ultimate tensile strength and elongation at room temperature, stress-rupture characteristics and creep resistance at room and elevated temperature, modulus of elasticity, yield strength, and corrosion resistance to various acid media. (See also AD-237798.) (auth)

5337 (AMC-TR-7-782(II)) THE DEVELOPMENT OF OPTIMUM MANUFACTURING METHODS FOR COLUMBIUM ALLOY FORGINGS. PHASE IIA: EVALUATION OF FOUR TECHNIQUES FOR CONSOLIDATION OF A COLUMBIUM BASE ALLOY (F48) CONTAINING 15%W, 5%Mo AND 1%Zr. Interim Technical Engineering Report II [for] February 1, 1960–September 15, 1960. R. F. Darby and R. O. Carson (Crucible Steel Co. of America. Research Lab., Penna.). 48p. Contract AF33(600)-39944.

Consolidation techniques (double vacuum arc melting, double electron beam melting, electron beam first melt followed by vacuum arc remelt, and a pressed and sintered ingot) were evaluated for fabricating a Nb–5Mo–15W–1Zr alloy (F48). The electron beam first melt plus vacuum arc remelted ingot exhibited the best over-all quality. The chemistry and macrostructure were uniform and, with the exception of low oxygen and marginally low zirconium, satisfied the chemical specifications. The double vacuum arc melted ingot was uniform in chemistry and, with the excep-

tion of high and variable oxygen content, met the specification requirements. A high segregated oxygen content made fabrication of this material difficult. The double electron beam melted ingot was very low in interstitial content and showed considerably more variation in chemical properties than the other ingots. The pressed and sintered ingot had low density (77%), and its chemistry was uniform except for high oxygen content. (For preceding period see AD-232423.) (C.J.G.)

5338 (BM-RI-5686) CASTING TECHNOLOGY FOR TITANIUM, ZIRCONIUM, AND HAFNIUM. S. L. Ausmus, F. W. Wood, and R. A. Beall (Bureau of Mines). July 1959. 34p.

The feasibility of casting titanium, zirconium, and hafnium by the consumable electrode skull-casting technique was studied. Graphite powder is suggested as the mold material, with emphasis on careful compounding of the binder. The effects of current and furnace atmosphere on the dependent variables of the casting technique are shown. (C.J.G.)

5339 (BMI-1475) PROGRESS ON THE USE OF GAS-PRESSURE BONDING FOR FABRICATING LOW-COST CERAMIC, CERMET, AND DISPERSION FUELS. PHASE II REPORT ON AEC FUEL-CYCLE PROGRAM. Stan J. Paprocki, ed. (Battelle Memorial Inst., Columbus, Ohio). Nov. 7, 1960. 95p. Contract W-7405-eng-92. OTS.

Uranium dioxide clad with Type 304 stainless steel was fabricated into rod, tubular, and flat-plate shapes by the gas pressure-bonding process. Modifications of these basic designs included compartmented rods, corrugated rods, and compartmented plates. The cold-compacting behavior in methods other than direct cold pressing and the pressure-bonding behavior of seven commercial oxides and various mixtures were defined. Through the selection of initial oxides and compacting procedures, final oxide densities of 86 to 99.5% of theoretical were achieved. It was noted that the oxides tend to approach stoichiometry during the pressure-bonding process. Permeability measurements of high-density pressure-bonded uranium dioxide resulted in values that were within the blank rate of measuring apparatus, indicating equivalence to high-density sintering oxides. Thermal-conductivity measurements on similar materials also are consistent with high-density oxide as prepared by pressing and sintering. Of the oxides investigated, mixtures of ceramic and fused oxides appear to offer the most promise of achieving low-cost fuel elements through the pressure-bonding process. Such mixtures containing from 30 to 60 wt. % ceramic oxide provide a high initial pressed density and also permit achieving a high final density. Both oxides are low-cost materials. The preparation and pressure bonding of uranium dioxide-stainless steel cermets were also briefly studied. Materials of densities up to 96.5% of theoretical were obtained. Modulus-of-rupture and thermal-conductivity measurements also were obtained on these materials. (auth)

5340 (DMIC-Memo-71) EXPLOSIVE METALWORKING. Charles C. Simons (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 3, 1960. 32p. (PB-161221). OTS.

The principles of impulsive or explosive forming of metals are discussed in generalities. The quality of the material formed by explosive means is discussed. (C.J.G.)

5341 (DMIC-Memo-75) REVIEW OF SOME UNCONVENTIONAL METHODS OF MACHINING. Francis W. Boulger (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 29, 1960. 23p. (PB-161225). OTS.

This review covers the principles and applications of four electrical machining techniques, as well as some information on chemical and ultrasonic methods. (W.L.H.)

5342 (NP-9477) BERYLLIUM CASTING. Interim Technical Report No. 8, Phase II [for] June 18, 1960 to September 17, 1960. Kenneth C. Taber and R. C. Harris (Beryllium Corp., Reading, Penna.). 37p. ASC Project No. 7-643. Contract AF33(600)-37902.

An evaluation of alloy additions of lanthanum and zirconium is described. Increasing columnar grain refinement results with increasing alloy additions of lanthanum. Zirconium as an alloying grain refiner has an optimum concentration of 0.40 to 0.60 wt. % for maximum columnar grain refinement. The step castings show the reduction of columnar grain size by increasing the cooling rate. Heat treating with prior cold reduction to promote recrystallization of the cast structure has yielded tentative relation for recrystallization time and temperature for 10% cold bare rolled cast beryllium. A trend has been observed with an optimum per cent cold reduction for a given heat treatment for maximum grain refinement. These tentative results require more work to definitely establish certain points. (auth)

5343 (NP-9481) FUSION WELDING OF BERYLLIUM. Progress Report No. 4 [for period] February 1, 1960 to April 30, 1960. Technical Report No. 181-220. Bruce M. MacPherson and W. W. Beaver (Brush Beryllium Co., Cleveland). Aug. 15, 1960. 16p. Project No. 7351. Contract AF33(616)-6413.

Sound welds were made on 0.125- and 0.250-in.-thick virgin and blend beryllium sheet by the tungsten-inert gas process. Attempts to fusion weld 1-in.-thick plate by the multipass technique were unsuccessful. Results of post-heat-treatment studies revealed that a longer time at temperature does not affect the fusion weld and that only the temperature at which the weld is post-heat-treated affects the welding properties. (See also NP-8626.) (C.J.G.)

5344 (NP-9495) INVESTIGATION OF SINTERABLE POWDERS AND BERYLLIUM OXIDE PROPERTIES. Sixth Quarterly Report. C. Hyde and W. H. Duckworth (Battelle Memorial Inst., Columbus, Ohio). Nov. 17, 1960. 15p. Contract AF33(616)-6238.

Little or no effect of sintering atmosphere was observed in the densification of compacts of MgO powders at 800 and 1100°F. Moisture in the sintering atmosphere impeded densification. A 1100°F calcine sintered to a density of 97.2 per cent theoretical at 2200°F in dried O or N; in normal air a sintering temperature of 2400°F was required to achieve this density. When the basic carbonate was overcalcined at 2400°F, Cl in the atmosphere promoted densification of the MgO powders, as did the use of a vacuum atmosphere at sintering temperatures above 2200°F. Soaking compacts of the 2400°F calcine for 50 hr produced greater densification than did a 1-hr soak, especially at higher sintering temperatures. (For preceding period see NP-8984.) (C.J.G.)

5345 (NP-9637) INVESTIGATION OF THE EFFECTS OF PROCESSING VARIABLES AND FABRICATION TECHNIQUES UPON THE PROPERTIES OF INTERMETALLIC COMPOUNDS. Technical Report No. 190-229. Progress Report No. 2 [for] July 1, 1960 to September 30, 1960. R. Truesdale, B. Lympany, J. Klein, M. Hornak, and W. W. Beaver (Brush Beryllium Co., Cleveland). Oct. 15, 1960. 33p. Contract AF33(616)-7108.

The optimum sintering temperatures of cold pressed $NbBe_{12}$, Nb_2Be_{17}, and Nb_2Be_{19} were established as 3050, 3090, and 3090°F, respectively. The compound Nb_2Be_{17} sintered to 97.5% of theoretical density. Sound 4-in.-square by 1-in.-thick blocks of Nb_2Be_{17} were fabricated and cut into transverse-rupture bars. A modulus of rupture strength of over 46,000 psi was measured at 2500°F. In the metallurgical phase, tungsten was found to be a suitable jacket material for the mechanical working of the niobium beryllides at 3000°F if protected from oxidation. Cera-kote, a refractory coating, sufficiently reduced tungsten oxidation for periods up to 1-hr. Two Nb_2Be_{17} specimens were upset at 2750°F and 7500 psi. An upset of 48% was achieved, causing a slight increase in density and grain size. (auth)

5346 (YAEC-140) FABRICATION OF A PROTOTYPE SILVER–INDIUM–CADMIUM CONTROL ROD ABSORBER SECTION FOR THE YANKEE REACTOR. E. S. Foster (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Aug. 1, 1960. 33p. For the Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

A Yankee prototype, 80% silver–15% indium–5% cadmium alloy, control-rod absorber section was manufactured in accordance with procedures and specifications recommended for making 24 similar control-rod absorbers for the Yankee Core I. Fabrication information is presented in detail. (auth)

5347 DETERMINATION OF HOOP STRESSES INDUCED IN A CYLINDRICAL STEEL DIE BY COMPACTING METAL POWDERS. S. J. Bustamante and H. Sheinberg (Los Alamos Scientific Lab., N. Mex.). Powder Met. No. 6, 36-51(1960).

Because of the lack of stress data, steel dies for compacting metal powders were designed in the past on the assumption of hydraulic pressure transmission by powders. True die stresses existing in a hardened steel die during the compacting of various lubricated and nonlubricated powders were measured by mounting strain-gages on the periphery of the die at numerous points along its length. Values of the hoop stress varied from approximately 0.05 to 0.40 of the calculated and measured hydraulic fluid stress. For a particular metal powder, the stress was a function of the average particle size, the powder height, and the amount of lubrication. (auth)

5348 THE COMPACTING OF METAL POWDERS BY EXPLOSIVES. W. T. Montgomery and H. Thomas (Imperial Chemical Industries, Ltd., Stevenston, Ayrshire, Eng.). Powder Met. No. 6, 125-8(1960).

A description is given of a technique developed for compacting metal powders by the use of detonating explosives under controlled conditions. Aluminum, iron, copper, and steel powders were originally compacted by this means into solid cylinders. Graphite and other nonmetal powders have recently been compacted, and modifications have been introduced whereby annular cylinders may be formed. This novel technique may find application in cases where existing mechanical methods of powder compacting are not adequate. (auth)

5349 HOT PRESSING OF CERAMIC POWDERS. A. G. Thomas and H. J. Jones (Plessey Co., Ltd., Towcester, Northants, Eng.). Powder Met. No. 6, 160-9(1960).

The processes involved in the production of dense ceramics from powder materials by the simultaneous effect of pressure and heat at temperatures above 1500°C are outlined. The factors leading to the choice of this method of fabrication and the general principles involved in hot pressing are dealt with, and the advantages and disadvantages of the process are discussed. Current techniques are described and their limitations considered. Examples of typical applications are given, and possible lines of future development are indicated. (auth)

5350 THE ISOSTATIC PRESSING, VACUUM SINTERING, AND SWAGING OF THORIUM POWDER. H. Lloyd and A. E. Symonds (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Powder Met. No. 6, 170-88(1960).

The isostatic pressing of calcium-reduced thorium powder into round bars and tubes prior to vacuum sintering and swaging is described. The simple equipment allows powder filling to be carried out in an enclosed system, thus avoiding fire and health hazards at this stage. A number of bars or tubes, or varying length and diameter, can be pressed simultaneously. The technique has certain advantages over conventional die compacting. The effect of pressure on density and hardness through the bar section before and after sintering at various temperatures was studied, and the optimum conditions were determined for the manufacture of dense bars with high metal efficiencies (98%). Details are given of the microstructure and mechanical properties of thorium bars in the sintered, swaged, and annealed conditions. (auth)

5351 WELDING OR BRAZING DISSIMILAR METALS. Jay Bland (Knolls Atomic Power Lab., Schenectady, N. Y.). Prod. Eng. 31, 4p.(1960) Dec. 19.

When design calls for joining dissimilar metals to form a pressuretight seal, welding or brazing is usually better than a mechanical joint. The most common processes for such metallurgical joining are: fusion-welding, brazing, and braze-welding. These heat the base metals and join them by melting or by wetting with a third material called the filler metal. Welding, which gives higher strength and is better suited to field operations, is preferable to brazing, unless the base metals are unsuitable. (auth)

5352 ARC MELTING AND FABRICATION OF TUNGSTEN. S. J. Noesen and J. R. Hughes (General Electric Research Lab., Schenectady, N. Y.). Trans. Met. Soc. AIME 218, 256-61(1960) Apr.

Several 4-in.-diameter tungsten ingots were arc melted in vacuum or in hydrogen atmospheres. Melting pressures, melt-off rates, effect of atmospheres, and other pertinent factors were examined. Two of these ingots were extruded at 1650°C. Subsequently, forging and rolling were carried out at lower temperatures. For a 60% area reduction by rolling, a 1-hr recrystallization temperature of 1250°C was obtained. This temperature is considerably lower than that reported in previously published work, and can probably be attributed to the extreme purity of the as-cast ingots (N, H, and O, all less than 1 ppm). (auth)

5353 MACHINE FOR EXTRUSION UNDER VACUUM. A. Gautier. Vide 75, 153-62(1958) May-June. (In French). (CEA-1061)

In a study of the behavior of easily oxidized metals during the extrusion process, it is first necessary to find an effective means of fighting corrosion, since this, even when barely detectable, has an important influence on the validity of the results recorded. The neatest and also the most efficient of all the methods tried consists in creating a vacuum around the test piece. Working on this principle, and at the same time respecting the conventional rules for extrusion tests (loading the sample after stabilization at the testing temperature, differential measurements of lengthening, etc.) it became necessary to construct an original machine. (auth)

5354 DRY PRESSING CERAMIC FUEL ELEMENTS TO CLOSE TOLERANCES. F. J. Hartwig (Babcock and

Wilcox Co., Alliance, Ohio). p.301-10 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Methods are presented for improving tolerances on dry-pressed ceramic fuel pellets for nuclear reactors. The basic principles of close control and the equation relating green and fired densities to dimensions are explained. A prediction is made of fired diameter based on green diameter and density with corrections for differential diameter to length shrinkage, volatile material losses, and other factors and is compared with experimental results. The agreement is good, and it is concluded that close tolerances are possible with care in measurements and fabrication. (auth)

5355 FABRICATION AND EVALUATION OF URANIA–ALUMINA FUEL ELEMENTS AND BORON CARBIDE BURNABLE POISON ELEMENTS. L. G. Wisnyi (Knolls Atomic Power Lab., Schenectady, N. Y.) and K. M. Taylor. p.311-17 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Urania–alumina fuel elements and boron carbide poison elements were fabricated by cold pressing and sintering and then ground to tolerances and evaluated for good corrosion resistance to water of pH 10 at 680°F, controlled density, close dimensional tolerances, and adequate strength. Both element types seemed to be satisfactory for reactor use, but suggestions for possible improvement are given. (D.L.C.)

5356 FABRICATION OF U_3O_8–ALUMINUM DISPERSION FUEL ELEMENTS BY EXTRUSION. R. A. Noland, D. E. Walker, and L. C. Hymes (Argonne National Lab., Ill.). p.336-44 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

A description is given of the coextrusion of aluminum-canned U_3O_8–aluminum powder mixtures to produce dispersion type fuel elements. The effects of powder preparation, extrusion billet can composition, extrusion ratio, extrusion temperatures, and tri-uranium octi-oxide (U_3O_8) content of the powder mixture are illustrated. Use of density measurements of individual elements to determine their U^{235} content is described. The process entails the hot extrusion of a powder mixture of U_3O_8 and aluminum, contained in an aluminum can, into a long aluminum-clad shape from which individual fuel elements are sheared. The fuel elements are of near theoretical density, integrally clad, and exhibit a uniform dispersion of fissionable material in the matrix. Core compositions from less than 10 to as high as 51 per cent by weight of U_3O_8 are shown to be feasible. A high conversion yield from billet to elements is regularly achieved. Reproducibility of the process is excellent; variation in the U^{235} content of fuel elements from identically charged billets is almost negligible. The process was used to produce the fuel loadings for the Argonaut Mark I Training Reactor (May 1956) and for the Argonaut G Reactor displayed at the 1958 Geneva Conference. (auth)

Properties and Structure

5357 (AD-235443) PHASE EQUILIBRIA BETWEEN B_2O_3 AND REFRACTORY OXIDES: THE SYSTEMS BeO–B_2O_3 AND ThO_2–B_2O_3. Quarterly Progress Report No. 2 [for] September 1 to November 30, 1959. D. E. Rase (New York. State Univ. Coll. of Ceramics, Alfred). 10p. Contract AF33(616)-6545.

In studies on the phase equilibria between B_2O_3–BeO systems and B_2O_3–ThO_2 systems, the volatility of B_2O_3 resulted in a change in the composition of samples heated at elevated temperatures. Procedures were developed for the determination of thorium, boron, and beryllium in each sample. (C.J.G.)

5358 (AD-239768) ADSORPTION OF SULFATES ON THORIA AT ELEVATED TEMPERATURES (thesis). Charles H. Hausenfleck (Utah. Univ., Salt Lak City). June 1960. 37p.

The adsorption of sulfates from aqueous solutions of potassium bisulfate and sodium sulfate on thoria under hydrothermal conditions was investigated at 100 to 290°C. The amount of adsorption as a function of temperature and sulfate concentration was determined. Sulfate adsorption on samples of ThO_2, having a nitrogen surface area of 32.4 m^2/gm, was found to increase with temperature and increasing H^+ concentration up to 205°C. Above this temperature a decrease in the amount adsorbed was noted. The adsorbed specie was identified as HSO_4^- ion. The data obtained suggest an esterification reaction involving molecular H_2SO_4 and surface ThOH sites with the subsequent splitting out of water. Adsorption isotherms obtained for a series of temperatures are of the form that indicates the reaction is one of chemisorption in which the standard free energy of adsorption varies with the absolute temperature and with the extent of surface coverage. Calculation of the activation energy and the entropy of adsorption for the process gave values of 10.0 kcal and 99 eu, respectively. The abnormally large positive entropy is explained in terms of the splitting out of water from the surface of thoria. (auth)

5359 (AFOSR-TR-60-170) RESEARCH ON STRAIN-AGEING, HARDENING AND SOFTENING OF METALS BY FATIGUE. Technical (Final) Report. PART I. FATIGUE OF ALUMINIUM–MAGNESIUM ALLOYS. G. W. J. Waldron and T. Broom. PART II. FATIGUE OF ZINC SINGLE CRYSTALS. J. M. Summerton and T. Broom (Birmingham. Univ., England). Aug. 1960. 90p.

As-extruded aluminum–magnesium alloys, in contrast to high-strength aluminum alloys of the age-hardening type, have high ratios of fatigue to tensile properties, and their S-N curves show fatigue limits. These excellent fatigue properties are believed to be due to magnesium atoms at dislocation lines inhibiting cross-slip, and metallographic work, together with the results of single crystal experiments, supports this hypothesis. Polycrystals of aluminum and aluminum–magnesium show hardening behavior after fatigue that is probably at least partially due to vacancies produced during the fatigue process. These defects become mobile at about –60°C in aluminum and aluminum–magnesium alloys as is shown by (a) the rate of decrease of fatigue life with increasing temperature at constant stress, checked in the alloys above –60°C, and (b) distinct aging and over-aging phenomena, observed when they are fatigued at –196°C, rested at –80°C or above, and then tensile tested at –196°C. Evidence is advanced for supposing that the lowest stress for fatigue failure in aluminum and aluminum–magnesium alloys may be correlated with the stress for beginning of cross-slip. Zinc single crystals have been fatigued at –196, –78, and +20°C, in push-pull tests at 100 c/s. Stresses of the order of one hundred times the flow stress of a virgin crystal can be reached. In tests at 20°C, the S-N curves of specimens having χ be-

tween 30 and 60° superimpose when plotted in terms of resolved shear stress on the basal plane. The fatigue failure is initiated by a small basal plane crack that forms at an azimuth corresponding to the active slip direction in the basal plane. Prismatic $\{1\,0\,\bar{1}\,0\}$ slip has been observed on specimens fatigued at −78 and +20°C, and a possible hardening mechanism whereby dislocations on basal and prismatic planes can interact is considered. Specimens fatigued at −196°C show a yield extension in a subsequent tensile test, and aging between −120 and −40°C after fatigue increases the stress at which yielding occurs. Specimens fatigue-hardened at −196 and −78°C have a strong temperature dependence of flow stress. These results suggest that point defects contribute to the hardening. (auth)

5360 (ARF-2175-12) AN INVESTIGATION OF METAL–CERAMIC COMPOSITES FOR HIGH TEMPERATURE APPLICATIONS. Final Report [for period] April 14, 1959–April 14, 1960. N. M. Parikh and J. I. Fisher (Illinois Inst. of Tech., Chicago. Armour Research Foundation). May 18, 1960. 35p. Contract DA-11-022-505-ORD-3038. (AD-238137).

A few systems of the metal-fiber reinforced-ceramic materials were investigated. Attempts were made to determine the nature and strength of the bond between metal and ceramics. Calculations of relevant values of residual thermal stresses were made from expansion measurements. Various properties of metal-fiber reinforced ceramics were measured, and they appeared to be a direct function of the volume fraction of metal. These properties were also very sensitive to the direction from which test specimens were cut from the composites owing to the anisotropy of metal distribution in the composites. These composites showed excellent thermal shock resistance at 1500°C. (auth)

5361 (BM-RI-5701) EFFECT OF IMPURITIES ON MECHANICAL PROPERTIES OF ELECTROLYTIC TITANIUM. J. D. Ramsdell and D. R. Mathews (Bureau of Mines. Reno Metallurgical Research Center, Nev.). June 1960. 15p.

The effects of the impurities oxygen, nitrogen, carbon, and iron (in low percentages) on the mechanical properties of electrolytic titanium were determined. The strength and hardness of binary Ti–O, Ti–N, and Ti–C alloys are linear functions of alloy content in the composition range investigated. Compared with oxygen and carbon, nitrogen is the most effective strengthener and hardener, followed by oxygen and then carbon. When the carbon concentration is above 0.10%, carbides are present; and strength and hardness are relatively unchanged. For equivalent hardness levels, Ti–Fe alloys are stronger than binary titanium alloys containing oxygen, nitrogen, or carbon. However, the strengthening is related to the presence of transformed β in the structure. (auth)

5362 (BRB-56) EFFECT OF TEMPERATURE AND GRAIN STRUCTURE ON THE FORMABILITY OF URANIUM. O. C. Carloni and L. Robins (Bridgeport Brass Co., Conn.). Oct. 28, 1960. 27p. Contract AT(30-1)-1405. OTS.

Drop-hammer tests were employed to compare the deformation resistance of fine-grained (hot-extruded) and coarse-grained (β- or γ-annealed) uranium at 25 to 750°C. The equicohesive temperature (ECT), where the deformation resistance of the fine- and coarse-grained structures were equal, was below the recrystallization temperature. The lower resistance of the fine-grained material above the ECT was verified by extrusion pressure data. The correlation of deformation resistance values calculated from the extrusion and drop-hammer data is discussed. A few samples were impacted in the β-phase range and cooled through the β-α transformation temperature while under a small stress. Surface appearance and metallographic evaluations were made. (auth)

5363 (DMIC-Memo-73) CURRENT NICKEL-BASE HIGH-TEMPERATURE ALLOYS. C. H. Lund (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 17, 1960. 12p. (PB-161223). OTS.

The properties of nickel-base alloys that are in current use for high-strength, high-temperature applications are reviewed. Ultimate tensile and stress-rupture strengths of nickel alloys at 68 to 1832°F are reported. (C.J.G.)

5364 (GA-1629) EFFECT OF ENVIRONMENT ON THE CREEP-RUPTURE PROPERTIES OF INCONEL 713C. J. C. Bokros (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 21, 1960. 19p. Contract AT(04-3)-187. OTS.

Tests were conducted on the creep-rupture properties of Inconel 713C in pure helium at 1300 and 1500°F. At 1300°F, rupture life and ductility of Inconel 713C in pure helium were equal to or greater than those measured in air; no effects of helium were observed at 1500°F. (C.J.G.)

5365 (NASA-TN-D-647) FATIGUE DAMAGE UNDER VARYING STRESS AMPLITUDES. H. W. Liu and H. T. Corten (Illinois. Univ., Urbana). Nov. 1960. 69p. OTS.

The influence of complex stress histories on the fatigue life of members was investigated to determine the relationship between fatigue life and the relative number and amplitude of imposed cycles of stress. A physical model of fatigue damage was formulated in terms of the number of damage nuclei initiated by the highest applied stress and the propagation of damage by all subsequent cycles of stress. Based on this physical model, a mathematical equation was derived that related the fatigue life to stress history. Further interpretation of this equation was made by an alternative hypothesis. Aluminum alloy, hard-drawn steel, and high-strength steel music wires were tested and the data statistically analyzed to obtain a measure of mean fatigue life and scatter. (auth)

5366 (NAVORD-6298) HIGH TEMPERATURE TESTING OF CERAMICS FOR RE-ENTRY BODY APPLICATIONS. F. J. Koubek and A. R. Timmins (Naval Ordnance Lab., White Oak, Md.). June 12, 1959. 54p.

A number of ceramic coatings were evaluated for possible application as thermal insulating coatings on heat sink type re-entry bodies. Heat shock and thermal insulation characteristics were studied in an oxy-acetylene test apparatus and in a supersonic hot air jet. The outstanding materials for the purpose were found to be stabilized zirconia and fused silica because of their ability to suppress the flow of heat and to resist thermal destruction. At heat fluxes of the order of 300 to 500 Btu/ft^2/sec (80 to 135 cal/cm^2/sec), stabilized zirconia coatings, 20 to 40 mils (0.5 to 1.0 mm) thick, suppressed the temperature rise of a copper substrate by a factor of 2 to 3 when compared to an uncoated substrate. Similar results were produced by fused silica. It was concluded that both stabilized zirconia and fused silica would make excellent candidates for further investigation as insulating, refractory coatings for heat sink type re-entry bodies. (auth

5367 (NP-9340(Vol. I)(Sect. IV)) ALUMINIUM AND STAINLESS STEEL AS CANNING MATERIALS. Ketil Videm (Norway. Institutt for Atomenergi, Kjeller). Sec-

tion IV of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 40p.

A material must meet a series of requirements in order to serve satisfactorily as a fuel element canning. These requirements concern strength and ductility, corrosion resistance, heat transfer, irradiation stability, structural stability, and induced radioactivity. In order to obtain aluminum with adequate corrosion resistance at higher temperatures, certain alloying constituents have to be added. The corrosion and mechanical properties of aluminum alloys are described. The mechanical properties, welding, and corrosive attack are treated in some detail. (W.D.M.)

5368 (NP-9418) PROPAGATING AND NON-PROPAGATING FATIGUE CRACKS IN METALS. R. C. A. Thurston (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Jan. 20, 1960. 48p.

Available as Can. Dept. Mines and Tech. Surveys, Mines Branch, Inform. Circ. IC 115. $0.25.

Methods of detecting crack initiation and of measuring subsequent growth are briefly discussed, and various analytical studies of fatigue-crack propagation are examined. The experimental results of crack growth in laboratory specimens and in simple and complex structures of ferrous and nonferrous alloys are reviewed and compared with theoretical predictions and general conclusions are drawn. The particular case of so-called nonpropagating cracks is considered, and conditions governing their initiation and development are outlined. The effect of fatigue cracks on static strength and on the subsequent response of the material to cyclic loading is discussed. (auth)

5369 (NP-9444) DIRECTORY AND BIBLIOGRAPHY OF HIGH-TEMPERATURE CONDENSED STATES RESEARCH IN CANADA AND ELSEWHERE, APRIL TO JUNE 1960. Norman F. H. Bright (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Aug. 25, 1960. 63p.

Available as Can. Dept. Mines and Tech. Surveys, Mines Branch, Inform. Circ. IC 119. $0.25.

This is the third quarterly bulletin of information on high-temperature research. It contains a bibliography of work on high-temperature condensed states published in Canadian journals during the period April to June 1960. Also included are bibliographies of work published in Austria, France, Belgium, Scandinavia, the U. S. S. R., and the U. S. A. during the period January to March 1960 and in Japan during the period July to December 1958. Lists of laboratories in Austria and in Japan engaged in high-temperature condensed states work and of the researchers involved are also included. (auth)

5370 (NP-9604) DEVELOPMENT OF ULTRA REFRACTORY MATERIALS. Summary Report [for] November 1, 1959 through October 31, 1960. Peter T. B. Shaffer (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). Dec. 15, 1960. 39p. Contract NOrd-17175.

The effort during this period was largely devoted to the investigation of an oxidation resistant composition, 90% ZrB_2–10% $MoSi_2$, discovered during the previous report period. Scouting experiments were made in other systems; however, no indications of oxidation resistance superior to the boride-silicide was noted. The major effort was, therefore, to measure the physical and chemical properties of the oxidation resistant material. Preliminary experiments have been conducted in the systems of mixed carbides of the Group IV and V metals to develop a composition with improved high-temperature strength for use as a back-up material for the oxidation resistant composition. (auth)

5371 (NP-9633) THE INFLUENCE OF SURFACE CONDITION AND CHEMICAL ENVIRONMENT ON DEFORMATION AND FRACTURE PROCESSES IN CERAMICS. Progress Report No. 1. B. G. Leonard, J. A. Nelson, R. F. Schneidmiller, C. S. Wilkinson, and J. F. Young (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Aug. 16, 1960. 13p. Contract AF33(616)-7315.

The effects of surface conditions and chemical environment on the deformation and fracture processes in ceramic materials were studied. Initial phase sintering is being investigated by study of cleavage crack fill-up in MgO single crystals subjected to various ambient conditions. Techniques are being investigated for use of electron micrographs to study surfaces of MgO crystals previous to and subsequent to sintering or mechanical treatments. (auth)

5372 (NP-9634) THE INFLUENCE OF SURFACE CONDITION AND CHEMICAL ENVIRONMENT ON DEFORMATION AND FRACTURE PROCESSES IN CERAMICS. Progress Report No. 2. B. G. Leonard, J. K. Okumura, R. F. Schneidmiller, C. S. Wilkinson, and J. F. Young (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Nov. 17, 1960. 13p. Contract AF33(616)-7315.

Examination of a number of cleaved surfaces of MgO crystals by electron microscopy to establish those characteristics that are significant is reported. Results are discussed and illustrated. In sintering experiments, further work toward establishing the nature of the fill-up material at the tips of cracks is reported. Deposition occurs only at grooves, or steps, and at the crack tip, eventually filling in the region completely. On the basis of micrographs, it appears that the fill-up material is MgO, and the deposit has the same lattice structure and orientation as the original crystal. Several crystals were exposed to different atmospheres in sequence. The results of fill-up of one such crystal are tabulated. Diffusion studies using radioactive iodine are reported. Results of these tests on diffusion of radioactive iodine into potassium iodide crystal at 250°C are tabulated. (For preceding period see NP-9633.) (J.R.D.)

5373 (NP-9654) POWDER NEUTRON DIFFRACTION STUDY OF THE ORTHORHOMBIC MODIFICATION OF LEAD MONOXIDE. (Neutronograficzne Badanie Struktury Ortorombowej Modyfikacji PbO). Report No. 128/I-B. J. Leciejewicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1960. 7p.

The oxygen positions in the orthorhombic modification of PbO were determined using powder neutron diffraction data. The character of the chemical bond in the lead monoxide is briefly discussed. (auth)

5374 (NYO-9625) THERMODYNAMIC PROPERTIES OF METAL CARBIDES AT HIGH TEMPERATURES. Final Report. [Pennsylvania. Univ., Philadelphia]. [1960]. 4p. Contract AT(30-1)-1976. OTS.

Thermodynamic properties of TiC, ZrC, Cr_3C_2, Mn_7C_3, and VC- were determined by measuring their equilibrium vapor pressure in graphite Knudsen cells. Brief details of the investigation of each carbide are included. (J.R.D.)

5375 (ORNL-3017(p.46-9)) ALLOY STUDIES. M. S. Weschsler, W. L. Harman, et al. (Oak Ridge National Lab., Tenn.).

The radiation-enhanced atomic rearrangement responsible for a decrease in the electrical resistivity of copper-aluminum alloys is being studied using electron and gamma irradiations. As the electron energies and fluxes are lowered, a smaller rate of decrease in resistivity is observed upon irradiation at a fixed temperature. A comparison of the flux dependence of the reaction upon electron

and γ irradiation with results previously obtained upon neutron irradiation leads to the conclusion that the annealing of radiation-produced defects involves some amount of vacancy-interstitial pair recombination. The annealing behavior of a deformed copper-silicon alloy suggests that enhanced atomic rearrangements may also take place following plastic deformation. The crystallographic theory of the martensitic cubic to orthorhombic phase transformation is described in terms of a generalized lattice-invariant shear. Certain solutions for the undistorted plane are given as explicit functions of the lattice parameters of the two phases. (auth)

5376 (ORNL-3017(p.116-24)) RADIATION METALLURGY. O. Sisman, R. G. Berggren, et al. (Oak Ridge National Lab., Tenn.).

The brittle fracture program for pressure-vessel steels was extended to include isothermal annealing studies. The results of impact tests showed some recovery at 400°F and 90% recovery at 850°F. In the tensile tests, slight recovery was observed between 250 and 400°F, and a very complicated behavior between 400 and 600°F was observed. A final stage of recovery was observed above 600°F. Stress-rupture studies were continued on Inconel and type 304 stainless steel by in-pile tube burst tests. Studies have also been initiated for beryllium, niobium, and Zircaloy-2. Tube burst tests are presently being assembled for all three new materials. Several experiments were run to determine the effect of internal helium generation on the physical and mechanical properties of beryllium. First tests on a high-temperature irradiation indicated that the swelling was much greater than observed from low-temperature irradiation followed by postirradiation annealing. (auth)

5377 (TID-11228) STUDY OF FACTORS INFLUENCING DUCTILITY OF IRON–ALUMINUM ALLOYS. Monthly Letter Report No. 7 [for] May 1, 1960 to April 30, 1961. George P. Rauscher, Jr., Frank C. Perkins, and Joseph F. Nachman (Denver. Univ. Denver Research Inst.). Dec. 9, 1960. 8p. Contract AT(11-1)-742. OTS.

Resistivity specimens of 16-Alfenal and Thermenal were machined from the as-rolled 0.035-in.-thick stock, annealed for varying lengths of time at 650°C to obtain the desired microstructures, and prepared to establish a high degree of Fe_3Al order. Resistivity measurements were made, the results of which are presented graphically. These isothermal resistivity curves were analyzed to establish the effects of heat treatment on the mechanical properties of the various alloys. Initial results of these studies are presented in relation to mechanical properties and hardness indentations. (For preceding period see TID-11106.) (J.R.D.)

5378 (TID-11235) A STUDY OF INCLUSIONS IN URANIUM. Progress Report. George L. Kehl and Eric Mendel (Columbia Univ., New York). Nov. 30, 1960. 50p. Contract AT(30-1)-1593. (CU-1-60-AT-1593-Met.).

Research during the report period was concerned with the changes in the character and properties of four common types of inclusions in uranium metal as a function of time at 810 and 1090°C. Uranium monoxide and uranium carbonitride were studied in some detail. Uranium monoxide is characterized by a complete or partial rim of UC. The inclusion proper has a lattice parameter of 4.930 A. Uranium carbonitride also has a lattice parameter of 4.930 A. Inclusions of both UC and UN are homogeneous in appearance without rims and are easily characterized. In other work research was conducted to examine a suggestion that a spurious plating behavior found in randomly distributed copper speckles in a uranium matrix may be due to the existence of a background precipitate. Experimental procedure is outlined, and results are discussed under the broad specimen classifications UC, UN, and U(C,N) type specimens. Photographic plates are included. (J.R.D.)

5379 (WADC-TR-59-762(Pt. III)) ULTRA-SHORT-TIME CREEP RUPTURE. [Period] covered: November 1959 to July 1960. C. W. H. Barnett (American Machine and Foundry Co. Advanced Research Dept., Alexandria, Va.). July 1960. 86p. Project No. 7381. Contract AF33(616)-6798. OTS.

The creep behavior of three structural sheet materials, namely, HM-21, H-11, and 310 stainless steel, was studied to temperatures up to 2,000°F within 200 msec. The recorded results are reported in tabular and graphical form. The testing procedure used in earlier work was modified for use in loading material simultaneously with the heating action. Data were obtained at four creep rates and at three loading rates. From the data obtained, curves of strain vs. time, isochronous stress vs. strain, and stress vs. time were plotted and are presented. (auth)

5380 (WADD-TR-60-463(Pt.I)) THE VAPORIZATION AND PHYSICAL PROPERTIES OF CERTAIN REFRACTORIES. PART I. TECHNIQUES AND PRELIMINARY STUDIES. A. A. Hasapis, M. B. Panish, and C. Rosen (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). Aug. 1960. Reprinted Oct. 1960. 75p. Project No. 4776. Contract AF33(616)-6840.

Simple effusion studies of the vaporization of rhodium, iridium, and osmium were undertaken by the Knudsen effusion technique. The rate of effusion was determined by condensing the molecular beam on a target. Rhodium was studied from 2051 to 2205°K. In this temperature range, its heat of vaporization was found to be 129 kcal/mole. Iridium was studied from 2100 to 2600°K. In this range, its tentative heat of vaporization is 155 ± 5 kcal/mole. It was noted that some interaction between the iridium, the thoria liner, and the tungsten outer liner of the effusion cell may have occurred. No data were obtained for the vaporization of osmium because of extensive interaction between the thoria liner and the tungsten outer liner of the effusion cell. Mass spectrometric studies have been made of the vaporization of thoria from tungsten effusion cells. Interactions between thoria and tungsten at elevated temperatures were noted. Tentative data on the vaporization of thoria to ThO and ThO_2 were obtained and are presented. Mass spectrometric studies of the vaporization of Al_2O_3 in contact with tungsten have been made in conjunction with compatibility studies of tungsten and Al_2O_3. Data are given for the vaporization of Al_2O_3 in tungsten to yield Al, AlO, Al_2O, and WO_2. More information will be needed before thermodynamic calculations can be made for this system. The continuously monitored effusion apparatus, the null-point effusion apparatus, the oscillating cup viscometer, and the sessile drop equipment have been constructed and calibrated. The viscosity of fused silica was determined at temperatures up to 2560°C, where $\eta = 10^{4.44}$ poises. The viscosity of alumina has been measured using an iridium crucible up to 2200°C and determined to be approximately 13 poises. (auth)

5381 (WADD-TR-60-646) CARBONIZATION OF PLASTICS AND REFRACTORY MATERIALS RESEARCH. Period covered: November 1, 1959 to June 30, 1960. J. A. Coffman, G. M. Kibler, T. R. Riethof, and A. A. Watts

(General Electric Co. [Flight Propulsion Lab. Dept., Cincinnati]). July 1960. 97p. Project No. 4776. Contract AF33(616)-6841.

Three complementary experimental techniques are being used to study the carbonization of plastics. These are thermogravimetric analysis, which gives an over-all picture of reaction rates under slow heating; fluid-bed carbonization of powdered resin, which provides insight into the mechanism; and arc image furnace experiments in which the plastics are exposed to temperatures approaching those of actual ablation applications. Vapor pressure studies are being conducted using the Langmuir evaporation technique. In addition matrix-isolation techniques and resonance-line absorption spectroscopy are being applied to the study of vapor species. Materials studied are tantalum carbide, zirconium carbide, and thoria. Normal spectral emissivities of tungsten, tantalum carbide and zirconium carbide were measured between 1800 and 3000°K using an emissometer designed and built for this purpose. Results of these studies are given and discussed. (auth)

5382 (AEC-tr-4276) ON A METHOD OF STUDY OF THE SELF-DIFFUSION OF TUNGSTEN. V. P. Vasilev and S. G. Chernomorchenko. Translated by Helen J. Chick and Richard Bidwell (Los Alamos Scientific Lab., N. Mex.) from Zavodskaya Lab. 22, 688-91(1956). 14p. JCL or LC.

Self-diffusion measurements on tungsten are described in which determinations were made continuously during the heating process. A tracer of W^{185} was used. Comparison of resulting data reveals that the activation energy for tungsten is higher than any metal examined except bismuth. (J.R.D.)

5383 (AEC-tr-4368) THE CERIUM OXIDE SYSTEM. G. Brauer and K. Gingerich. Translated by Karl S. Vorres (State Univ. of Iowa) from Angew. Chem. 69, 480(1957). 2p. JCL.

X-ray photographs were used to show that the miscibility gap between the compositions $CeO_{2.00}$ and $CeO_{1.81}$ is evident to a marked degree only at temperatures up to 200°C, becoming narrower with rising temperature and closing at 685°C. Other information on the system is included. (J.R.D.)

5384 (AEC-tr-4372) A FEW PROPERTIES OF THE RARE EARTH OXIDES. [PART] II. W. Noddack and H. Walch. Translated by Karl S. Vorres (State Univ. of Iowa) from Z. physik. Chem. (Leipzig) 221, 194-207(1959). 21p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 22771.

5385 (CEA-tr-R-969) ETUDE DE LA VITESSE DE DÉCARBURATION DE TUBES EN ACIER 30 KhMA EN PRÉSENCE D'HYDROGÈNE. (Study of the Decarburation Rate of 30 KhMA Steel Tubes in the Presence of Hydrogen). V. V. Ipat'ev (Ipatiev), O. N. Merkulov, and V. I. Teodorovich. Translated into French from Zhur. Priklad. Khim. 31, 1891-4(1958). 9p.

The rate of decarburation of 30 KhMA steel tubes in hydrogen at 400 to 600°C and 100 to 700 atm. was studied. At 575°C and with varying pressure, the results show that decarburation begins after an incubation period; and the rate is proportional to the square root of time. The incubation period is an inverse function of pressure. Studies with constant pressures and varying temperatures result in the expression $\log K = (-15{,}000/2.3\ RT) + 0.0034\ P + 1.13$ for the decarburation rate. (T.R.H.)

5386 (NP-tr-530) PROSPECTS FOR USING REFRACTORY COMPOUNDS IN THE CHEMICAL INDUSTRY. (Perspektivy Primeneniya Tugoplavkikh Soedineniy v Khimicheskoy Promyshlennosti). G. V. Samsonov. Translated from Khim. Nauka i Prom. No. 6, 807-11(1958). 19p. OTS.

The development of many areas of modern chemistry is connected with the use of wear-, erosion-, corrosion-, and heat-resistant materials. Carbides, borides, nitrides, and silicides of refractory metals and also of certain nonmetals are important classes of these materials, together with metals such as tantalum, niobium, titanium, and others. The basic physical properties of these compounds in comparison with the properties of refractory metals are listed. (W.L.H.)

5387 (NP-tr-535) [CASTING INDUSTRY]. Translation of Selected Articles from Liteĭnoe Proizvodstvo No. 5, 28-34(1959). 34p. OTS.

Four papers are included in this volume which cover the following subjects: mechanism of modifying some aluminum alloys; production of zirconium master alloy; elimination of cracks in magnesium alloy casting; and use of boron chloride in casting magnesium alloys. (W.L.H.)

5388 A TEST FOR ELECTRON TRANSFER IN V_4Al_{23}. A. E. Ray and J. F. Smith (Ames Lab., Ames, Iowa). Acta Cryst. 13, 876-84(1960) Nov.

Three-dimensional intensity data were collected from a spherical crystal of V_4Al_{23} by the moving crystal-stationary counter technique. Corrections were made for the effects of absorption, dispersion, extinction, and anisotropic thermal motion of the atoms. The crystal structure was refined by the method of least squares and by difference syntheses to a reliability index of 0.057. The intensity data were placed on an absolute scale using only those reflections for which $(\sin\theta)/\lambda > 0.29\ A^{-1}$ and which are relatively insensitive to the distribution of the outer electrons. Difference syntheses were then computed for the reflections $(\sin\theta)/\lambda < 0.29\ A^{-1}$ which are most sensitive to the distribution of the outer electrons. These difference syntheses are a measure of the difference between the equilibrium electron distribution in the crystal and that in the isolated free atoms. The results do not indicate a significantly increased electron concentration in the vanadium d levels as proposed by Raynor. (auth)

5389 X-RAY MICROSCOPY OF BERYLLIUM. J. Sawkill and D. R. Schwarzenberger (Tube Investments Research Labs., Cambridge, Eng.). Brit. J. Appl. Phys. 11, 498-503(1960) Nov.

The point-projection x-ray microscope was used to study a variety of beryllium specimens, ranging from single crystals to finely-polycrystalline metal containing inclusions. The highly divergent beam of x rays from a source 1 μ in diameter gave, on the same photograph, a microradiograph of the specimen with a resolution of 1 μ and a divergent beam diffraction pattern. Together these can give information about the distribution of heavier elements or cracks in the beryllium, the variation in perfection of the crystal lattice and, with a single crystal, the orientation and lattice parameters of the specimen. (auth)

5390 WEAR OF THE HARD AND SOFT PHASES IN COBALT-BONDED TUNGSTEN CARBIDE. J. Golden and G. W. Rowe (Tube Investments Research Labs., Cambridge, Eng.). Brit. J. Appl. Phys. 11, 517-20(1960) Nov.

It was previously widely accepted that the normal wear pattern of cobalt-bonded tungsten carbide is a steady attrition of the soft matrix, leading to occasional loosening of

hard carbide grains. This hypothesis, was based on visual examination of autoradiographs of copper wire drawn through radioactive tungsten carbide dies. Experiments showed that autoradiographs of this type, having a steady general level of blackening with local dense spots superimposed, are obtained if the copper surface is not sufficiently well prepared. On smooth surfaces uniform autoradiographic density was observed. Detailed measurements of the former type of autoradiograph were made, showing first the short-lived tungsten activity and finally the long-lived cobalt activity. These refuted the suggestion that the spots are carbide grains and that the general level is cobalt. The composition of the wear deposit in both was the same, and corresponded closely to the initial composition of the bonded carbide. The revised picture of steady continuous wear of both phases concurrently, accords with other experimental evidence quoted. (auth)

5391 THE USE OF SLIGHTLY ALLOYED URANIUM AS FUEL: ITS INFLUENCE ON THE DISSOLUTION AND OTHER STAGES OF TREATMENT. P. Faugeras, P. LeRoy, and C. Lheureux. Compt. rend. congr. intern. chimie ind., 31e, Liège, 1958. Ind. chim. belge, Suppl. 1959. 8p. (In French). (CEA-1316)

A study was made of binary alloys (UAl, UMo, UZr, UCr, USi) with a low concentration of the additional element (≤ 2 per cent). The investigation was pursued with a view to the continued utilization, with a minimum of modification, of the existing plants for treatment of non-alloyed irradiated uranium. In the first part, the usual process for the treatment of irradiated uranium by solvent extraction is briefly recalled. The second part is devoted to a study of the selective dissolution of the canning around certain of these alloys. The third part gives the behavior of these different alloys at various phases of the usual treatment: dissolution; extractions; final treatment of fission products; and final purification of plutonium. Possible alloys are classed as a function of their repercussions on the normal treatment. (auth)

5392 ELECTRIC, THERMO-ELECTRIC AND GALVANOMAGNETIC PROPERTIES OF TRANSITION METAL SILICIDES. V. S. Neshpor and G. V. Samsonov (Inst. of Metalloceramics and Special Alloys, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 817-20(1960) Aug. 1. (In Russian)

Electro-resistance, thermo-electromotive force, and Hall effects were studied in transition metal silicides of groups IV to VII and in rare-earth metal silicides (lanthanum, cerium, and praseodymium). The electric resistance, plotted as a function of silicon content, shows that all silicide systems can be divided into two groups. In the first group (Ti, Zr, V, Ta, W, and Mo) the resistance in intermediate phases is reduced by an increase in silicon content. In the second group (Cr, Fe, Re, and Mn) increased silicon increases the resistance of intermediate phases up to 10^2 to 10^3 μ ohms cm. All high silicon systems of the first group have positive resistance temperature coefficients and weak thermo-electromotive forces, while the second group has a negative resistance temperature coefficient with strong thermo-electromotive force. The tabulated data show that values n^e calculated per molecule of compounds having negative Hall coefficients do not differ greatly from the whole numbers, except for PrSi. Moreover, the magnitude is either equal or several units smaller than the total number of valence electrons in the metal atoms. Consequently, in contrast to transition metals with predominant vacancy conductivity, the silicides (except for molybdenum and tungsten silicides) are electron conductors. (R.V.J.)

5393 NEW GRAPHITE TAKES MORE HEAT. Iron Age 186, No. 20, 151(1960) Nov. 17.

A hot-working process was developed to produce a recrystallized high-density graphite for high-temperature applications. The new graphite has about two or three times the high-temperature strength of standard graphites and has been produced with densities of 2.16 g/cc. The room-temperature flexural strength is ~6000 psi, which increases with temperature, until at 4500°F, the strength is about double the room temperature value. In rocket motor tests, nozzle inserts made from the graphite compared favorably with other well-known high-temperature materials. (B.O.G.)

5394 RELATION BETWEEN THE HEAT RESISTANCE AND CREEP OF ALLOYS AND THEIR CONSTITUTION DIAGRAM. V. K. Grigorovich, and Yu. S. Safronov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 38-46(1960) Sept.-Oct. (In Russian)

The short time hardness and creep of binary zirconium alloys with 0.1 to 5 at. % Sn, Ni, Fe, and Cr increase with alloying content at 20° and 700°C. The minimum creep in α solid solution is reached at 5 to 10 at. % titanium and 1 to 5 at. % zirconium, whereas the maximum is reached with 50 at. % titanium. (R.V.J.)

5395 RARE-EARTHS IN HIGH MELTING ALLOYS. E. M. Savetskiĭ. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 52-69(1960) Sept.-Oct. (In Russian)

Applications of rare metals as bases in high-melting alloys or as modifying, oxidizing, disulfurizing, degasing, and strengthening admixture are reviewed. 51 references. (R.V.J.)

5396 RECRYSTALLIZATION OF CAST HEAT-RESISTANT NICKEL ALLOY. Z. S. Bychkova, Yu. V. Vinogradov, A. N. Danil'chenko, M. Ya. Dzugutov, V. Ya. Mezis, M. V. Rastegaev, and V. P. Stepanov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 70-8(1960) Sept.-Oct. (In Russian)

Recrystallization diagrams are plotted for uniformly precipitated cast nickel alloy and hot deformed, annealed metal (1200°) considering the soaking time. The mechanism of recrystallization and deformation are analyzed and conditions producing improved heat-resisting crystal structure are found. (R.V.J.)

5397 PLASTIC DEFORMATION OF HIGH MELTING METALS AT ELEVATED TEMPERATURES. L. I. Ivanov, M. P. Matveeva, and D. A. Prokoshkin. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 79-85 (1960) Sept.-Oct. (In Russian)

The creep of titanium, niobium, and chromium was studied at various temperatures. It was found that with the increase of applied force the creep activation energy is reduced in chromium and niobium, whereas in titanium it remains unchanged. The Q_{creep} of titanium (absolute value) is less than the self-diffusion activating energy. The creep activation energy for chromium and niobium at $\tau = 0$ is a complex magnitude that in first approximation is equal to the sum of self-diffusion activation energy and the vacancy forming energy. Microscopic analysis exhibits a dislocation mechanism in chromium plastic deformation at high temperatures (1400°C). The polygonization process is analyzed, and it is shown that polygonization appears at the beginning of the second stage of creep. (R.V.J.)

5398 COMPOSITION, TEMPERATURE, AND HEAT RESISTANCE RELATION IN THE Ni–Cr–W–Ti–Al ALLOYS. I. I. Kornilov, O. V. Ozhimkova, and L. I. Pryak-

hina. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 137-41(1960) Sept.-Oct. (In Russian)

A constitution diagram was developed for Al–Cr–Ni–Ti–W alloys with Al contents from 0 to 16%. The heat resistance of the alloy was determined at 700, 800, 950, 1000, 1100, and 1200°C. (R.V.J.)

5399 BENDING TESTS OF Ti–Cr–Al ALLOYS AT ELEVATED TEMPERATURES. V. S. Mikheev and T. S. Chernova. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 142-5(1960) Sept.-Oct. (In Russian)

Bending in Ti–Cr–Al alloy specimens with Cr–Al ratios of 1:9, 1:1, and 3:1 was investigated. The best resistance was found in α solid solutions with heterogenic microstructure (Cr:Al ratio 1:9), whereas alloys with Cr:Al = 1:1 and 3:1 exhibited little bend resistance at 550°C and 15 kg/mm^2 pressure. (R.V.J.)

5400 THE DEPENDENCE OF CREEP ACTIVATION ENERGY IN α Ti ON INTENSITIES. K. A. Osipov and A. L. Sotnichenko. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 146-8(1960) Sept.-Oct. (In Russian)

Creep tests of α titanium were carried out at 18 to 600°C and 10 to 35 kg/mm^2 pressure. The logarithms of creep rate are plotted as functions of creep activation energy, intensities, and temperature. (R.V.J.)

5401 NEUTRON AND OPTICAL STUDIES OF DOMAINS IN NiO. W. L. Roth (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys. 31, 2000-11 (1960) Nov.

Antiferromagnetic domains in NiO were studied by neutron diffraction and optical observation of single crystals. There are two kinds of antiferromagnetic domain walls, T (twin) and S (spin-rotation). A T wall is produced by rotation of the antiferromagnetic pattern of magnetic moments and an S wall by rotation of the direction of the magnetic moments. The T walls can be observed with polarized light, and both T- and S-type domains can be studied by neutron diffraction. Crystals with simple T-wall structures are produced by annealing at high temperature. The crystallography of the T walls can be understood in terms of a small rhombohedral deformation which accompanies the antiferromagnetic ordering. The T walls are easily displaced by the application of small mechanical stresses or magnetic fields. A crystal without T walls may still contain S walls, and these S walls are displaced or rotated by magnetic fields. (auth)

5402 MATERIALS SELECTOR ISSUE. Materials in Design Eng. 52, No. 6, 1-592(1960) Mid-Nov.

The latest available data on engineering materials, forms, finishes, and joining and fastening methods are presented. The two main sections are the data section and directory section. In the data section there are tables comparing the important engineering materials with respect to particular properties. Typical properties and uses of irons and steels, nonferrous metals, plastics and rubber, other nonmetallics, and finishings and coatings are tabulated. Data on the joining and fastening methods used for engineering materials are also included. The directory section contains the names and addresses of the leading suppliers of engineering materials. (M.C.G.)

5403 ASTROLOY—A SUPERALLOY FOR 1900°F USE. J. F. Barker, W. H. Couts, Jr., and R. J. Morris (General Electric Co., Evendale, Ohio). Metal Progr. 78, No. 6, 94-7(1960) Dec.

This latest nickel-base superalloy contains, among other alloying elements, 4.5% aluminum, 3.5% titanium, and 0.03% boron. It has excellent yield strength and stress-to-rupture properties and can be readily shaped and welded while in the annealed condition. These properties are expected to make the alloy useful in jet engine components such as turbine blades. (auth)

5404 RETAINED AUSTENITE AND THE TEMPERING OF MARTENSITE. S. Matas and R. F. Hehemann (Case Inst. of Tech., Cleveland). Nature 187, 685-6(1960) Aug. 20.

An investigation was made of the influence of retained austenite on the first-stage tempering reaction of martensite to determine if it is possible to distinguish between the two interpretations of the matrix carbon content of martensite. Two steel samples were prepared and quenched in water after 24 hr at 2400°F, thus producing 40 to 50% martensite. One of the samples was cooled immediately in liquid nitrogen, which increased the martensite to 90%. The oscillating crystal technique was used to determine the carbon content of the martensitic matrix after appropriate tempering at 270°F. The partition of carbon from martensite to austenite indicates that the low-carbon martensite composition must be attributed to the metastable equilibrium involving ϵ carbide rather that that involving retained austenite. The partition of carbon from martensite to austenite may contribute significantly to property changes associated with tempering. It is apparent that tempering is more complicated than current theoretical treatments predict, so that a re-examination of tempering kinetics in light of this and other phenomena may provide a deeper and more satisfying understanding of the theory of tempering processes. (B.O.G.)

5405 ANGULAR CORRELATION STUDIES OF THE $Be^9(\alpha,n\gamma)C^{12}$ REACTION. J. B. Garg, J. M. Calvert, and N. H. Gale (Univ. of Manchester, Eng.). Nuclear Phys. 19, 264-79(1960) Oct. (3). (In English)

Several angular distributions and (n, γ) correlations of the neutron group corresponding to the 4.43-Mev level of C^{12}, produced in the reaction $Be^9(\alpha, n\gamma)C^{12}$, were measured using time-of-flight techniques. Bombarding energies of 3.35 and 5.10 Mev were used. Results were analyzed in terms of direct interaction mechanisms. The angular distributions show forward peaking and can be fitted reasonably well by Butler's theory assuming contributions from $l = 1$ and $l = 3$ but require a rather large value of the radius parameter. Angular correlation measurements were made in the reaction plane for neutrons emitted at 10, 20, and 75° to the direction of the incident beam at energies of 3.35 and 5.10 Mev. These were fitted by a sum of even order Legendre polynomials. The correlations show marked changes both with neutron angle and bombarding energy, but the symmetry axis is in most cases not very far from the direction of momentum transfer. These results would suggest interference either from different reaction mechanisms, different l-values, or both. (auth)

5406 ON THE EXISTENCE OF A CRITICAL POINT FOR THE PHASE TRANSITION IN CERIUM. R. I. Beecroft and C. A. Swenson (Ames Lab., Ames, Iowa). Phys. and Chem. Solids 15, 234-9(1960). (In English). (IS-52).

A piston-displacement technique was used to examine the phase transition in cerium to 20,000 atm and 575°K. The results are in agreement with previous thermal data, and show that the volume change decreases with increasing temperature, extrapolating to zero somewhere near 630°K and 20,000 atm. Above roughly 500°K and 15,000 atm, however, the transition becomes increasingly spread out in

pressure at constant temperature; and it becomes quite difficult to assign values to the transition pressures and the volume changes. Although there are definite indications that the nature of the transition is changing at these pressures and temperatures, the possibility that the transition is merely becoming sluggish cannot be ruled out. (auth)

5407 ZINC RECRYSTALLIZATION AND SINGLE CRYSTALS PRODUCTION BY THERMAL CYCLING. Dante Buttinelli (Università, Rome) and Giuseppe de Gregorio. Ricerca sci. 30, 739-42(1960) May. (In Italian). (CNEN-8)

A study was made of the effects of thermal cycling on the recrystallization of pure zinc with different original pretreatments. The existence of three rates of recrystallization is noted and also the possibility of producing single crystals by thermal cycling. (auth)

5408 PRECISION LATTICE PARAMETER DETERMINATION OF ZIRCONIUM–OXYGEN SOLID SOLUTION. Barry D. Lichter (Air Force Cambridge Research Center, Bedford, Mass.). Trans. Met. Soc. AIME 218, 1015-18 (1960) Dec.

The lattice parameters of zirconium and zirconium–oxygen solid solutions (hcp) were determined from measurements of back-reflection x-ray photograms obtained at 29°C using a symmetrical focusing camera. The following linear equations between parameters (c,a) in angstrom units and atom ratio (m) of oxygen to zirconium were obtained: $c = 5.14764 + 0.2077\ m$ and $a = 3.23168 + 0.1099\ m$. The linear equations given are valid over the range 0 to 5 at. % oxygen. The accuracy of individual parameter measurements approaches the limiting accuracy determined by the spectral broadening of the incident characteristic radiation, and exceeds the accuracy of previously reported values. (auth)

5409 A FURTHER STUDY OF Ti_2Ni-TYPE PHASES CONTAINING TITANIUM, ZIRCONIUM OR HAFNIUM. M. V. Nevitt, J. W. Downey, and R. A. Morris (Argonne National Lab., Ill.). Trans. Met. Soc. AIME 218, 1019-23 (1960) Dec.

The occurrence of Ti_2Ni-type phases in binary and ternary alloys of titanium, zirconium, or hafnium with first, second, or third long-period transition metals and also in ternary systems in which oxygen is the third component was studied. The existence of eleven previously unreported isomorphs is reported and some approximate phase boundaries are given. Lattice parameters are reported for the new phases. The periodic table relation involved in the occurrence of the phase is discussed. (auth)

5410 SOME REFRACTORY URANIUM COMPOUNDS—PREPARATION AND PROPERTIES. M. J. Snyder and A. B. Tripler, Jr. (Battelle Memorial Inst., Columbus, Ohio). p.293-300 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

In a program on possible new compounds for nuclear fuels, the refractory uranium compounds UC, UC_2, UN, UB_2, and UBe_{13} were investigated. Methods of preparing these compounds and techniques for sintering them to densities of 90 per cent or greater are described. The carbides were prepared by arc-melting stoichiometric mixtures of uranium metal and high-purity carbon. The mononitride was prepared by first forming U_2N_3 by reaction of powdered uranium metal and nitrogen; the sesquinitride was subsequently converted to the mononitride by heating at a reduced pressure. The diboride was formed by the solid-solid reaction of UH_3 and boron powder at 1300 to 1400°C. The beryllide was prepared by heating a mixture of UH_3 and beryllium metal (with beryllium in excess) in an argon atmosphere at 1550°C. Dense specimens for property measurements were fabricated by hydrostatic pressing of fine powders, obtained by crushing and grinding the compounds, and sintering the compacts in vacuum or in argon at temperatures ranging from 1550°C for UBe_{13} to 1850°C for UN. Thermal expansion was measured for the beryllide and the monocarbide. The mean linear coefficient from 20 to 1000°C was 14.2×10^{-6} per °C for UC and 16.7×10^{-6} per °C for UBe_{13}. The thermal conductivity of the beryllide was found to be appreciably higher than that of uranium dioxide and to approach that of uranium metal. The rate of reactions of several of the compounds with water vapor, oxygen, and nitrogen at temperatures up to 500°C was investigated. In general, the compounds were most resistant to nitrogen and reacted most rapidly with oxygen. The beryllide was generally the least reactive of the compounds and reacted less rapidly than uranium metal with the three gases. The diboride reacted with oxygen more rapidly than did uranium metal but was more resistant than uranium to water vapor and nitrogen. The dicarbide reacted most rapidly, and its rate of reaction was greater than that of uranium metal with the three gases. (auth)

5411 FRACTURE. Proceedings of an International Conference on the Atomic Mechanisms of Fracture held in Swampscott, Massachusetts, April 12-16, 1959. B. L. Averbach, D. K. Felbeck, G. T. Hahn, and D. A. Thomas, eds. Cambridge, Mass., Massachusetts Institute of Technology and New York, John Wiley & Sons, Inc., 1959. 660p.

Twenty-eight papers presented at the International Conference on the Atomic Mechanisms of Fracture held in Swampscott, Massachusetts, April 12 to 16, 1959, are included. Three of these papers are covered by separate abstracts. (M.C.G.)

5412 INTERCRYSTALLINE FAILURE AT HIGH TEMPERATURES. N. J. Grant (Massachusetts Inst. of Tech., Cambridge). p.562-78 of "Fracture."

The influence of composition and testing variables on the incidence of intercrystalline fracture is discussed. Experimental results are presented that illustrate the effect of deformation, test temperature, and stress on the extent of grain-boundary sliding in aluminum alloys. Theories of intercrystalline fracture and the role of grain-boundary sliding, void formation, grain-boundary migration, and dislocation pile-ups are assessed. (auth)

5413 MECHANISMS OF INTERGRANULAR FRACTURE AT ELEVATED TEMPERATURES. R. C. Gifkins (Univ. of Melbourne). p.579-627 of "Fracture."

Fracture in creep in which intergranular fracture at elevated temperatures is most prevalent is reviewed. Evidence and models for grain-boundary sliding are presented. Measurements made on bicrystal and polycrystalline specimens are summarized. Evidence is given of the initiation of intergranular cracks in a variety of metals and alloys. These results are discussed in relation to the mechanisms of crack formation at grain boundaries. It was concluded that grain-boundary sliding is concerned in initiating most cracks and that vacancy condensation may be important in the growth of cavities that precede cracking. The role of various metallographic features is also discussed. (auth)

5414 CLEAVAGE IN THE REFRACTORY METALS. J. H. Bechtold (Westinghouse Research Labs., Pittsburgh). p.628-40 of "Fracture."

The low-temperature fracture and yielding of the refractory metals vanadium, chromium, niobium, tantalum, molybdenum, and tungsten are discussed. Differences in behavior, rather than similarities, are emphasized. The temperature dependence of the yield strength is considered. Evidence that brittle fractures of molybdenum samples originate at grain-boundary cracks is presented. The brittleness in this case is associated with impurities segregated at the grain boundaries. Changes in the magnitude of the preyield strain, measured at different temperatures, and the formation of cracks are explained in terms of dislocation pile-ups. (auth)

Radiation Effects

5415 (BMI-1476) EFFECTS OF IRRADIATION ON THE MECHANICAL PROPERTIES OF TANTALUM. Charles K. Franklin, David Stahl, Frederic R. Shober, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Nov. 18, 1960. 21p. Contract W-7405-eng-92. OTS.

Tensile, bend ductility, and hardness tests were performed at room temperature on irradiated tantalum sheet to determine the effect of irradiation on the strength and ductility. Sheet tensile specimens were irradiated in an attempt to produce conversions of tantalum to tungsten of approximately 1.5 and 3.0 wt. %. Unirradiated tantalum and arc-melted alloys of tantalum-1.5 and -3 wt. % tungsten were tested for comparison with the irradiated material. The tensile and yield strengths of tantalum were found to increase appreciably as a result of irradiation, whereas the tensile properties of unirradiated Ta–W alloys prepared by arc melting showed that small additions of tungsten do not significantly increase the strength of tantalum. These results indicate that the major part of the increase in strength resulting from irradiation of tantalum can be attributed to fast-neutron damage and that any contribution produced by the conversion of tantalum to tungsten is a minor one. (auth)

5416 (BMI-1483) THE EFFECT OF RADIATION ON SELECTED PROPERTIES OF SPHERICAL GRAPHITE FUEL ELEMENTS. Allison K. Smalley, Richard J. Burian, Arnold F. Gerds, Gilbert E. Raines, and Ward S. Diethorn (Battelle Memorial Inst., Columbus, Ohio). Dec. 2, 1960. 21p. Contract W-7405-eng-92. OTS.

As part of the fuel-element-evaluation program for the Pebble Bed Reactor, 1.5-in.-diameter graphite spheres fueled with UO_2, UC_2, and UC particles were irradiated at 1300 to 1700°F to U^{235} burn-ups of 1.6 to 8.6 at.%. The study included bare graphite spheres and spheres coated with siliconized silicon carbide and pyrolytic carbon. Postirradiation studies consisted of visual examination, measurement of weights and dimensions, metallographic examination, and coating leakage, impact, and compression tests. Of the six coated spheres, only two, coated with silicon carbide, did not have cracks in the coating after irradiation. One of these two had a small pinhole leak in the coating. The other was leak-free. Cracks and pinholes penetrated to the fueled-graphite matrix. The uncoated graphite spheres contracted. Diameters decreased 0.2 to 0.9%. These decreases are not easily correlated with burn-up. Highly graphitized spheres showed more contraction than spheres containing less-ordered carbon structures. Weight losses were generally observed but were probably not the result of irradiation. The fueled matrices were changed very little, the predominant effect being a hardening or contraction of the matrix surrounding the fuel particles. Little change in impact strength was observed. The compressive strengths of all spheres increased during irradiation. (auth)

5417 (CRFD-817) THE DEPENDENCE OF THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE ON DENSITY, MICROSTRUCTURE, STOICHIOMETRY AND THERMAL-NEUTRON IRRADIATION. A. M. Ross (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1960. 61p. (AECL-1096). AECL.

Polycrystalline UO_2 samples were prepared in a wide range of densities. Their thermal conductivities were measured at 60°C by a comparative steady-state heat-flow method as a function of density, microstructure, stoichiometry, and thermal-neutron irradiation. The thermal conductivities of several polycrystalline UO_2 samples in the UO_2–U_3O_8 region decreased with increasing oxygen-to-uranium atomic ratio. This dependence was attributed to the presence of a precipitated U_4O_9 phase in the nonstoichiometric samples. The thermal conductivity of polycrystalline U_3O_8 was approximately 25% of that for stoichiometric UO_2. Postirradiation thermal-conductivity measurements were made at 60°C on several UO_2 samples which had been irradiated below 500°C to various exposures. After a thermal-neutron irradiation of approximately 2.10^{17} neutrons/cm^2 the conductivity was 26% lower than that obtained for unirradiated samples. Irradiations up to 6×8.10^{19} neutrons/cm^2 caused no further decrease in thermal conductivity. The irradiated samples were then annealed in vacuum at temperatures up to 1000°C. The resulting changes in their thermal conductivities indicated that the complexity of the radiation damage in the samples increased with increasing exposure. (auth)

5418 (NAA-SR-Memo-3994) PROMPT RADIATION EFFECTS ON CABLES AND LINEAR POWER INSTRUMENTATION CHANNELS. S. P. Harris and E. L. Gardner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1959. 9p. OTS.

Tests were conducted to determine the amount of error introduced in reactor power data by radiation-induced voltages in cables and electrometer preamplifier chassis. The results, obtained near the central exposure facility of the KEWB (Reactor Safety Experiments), showed no observable radiation effects under the conditions of present use. Cable insulation resistance was measured during the radiation bursts. (C.J.G.)

5419 (NASA-TN-D-477) SURVEY OF MATERIALS PROBLEMS RESULTING FROM LOW-PRESSURE AND RADIATION ENVIRONMENT IN SPACE. Robert A. Lad (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1960. 20p. OTS.

The possible detrimental effects of the low-pressure and radiation environments on the utility of pure metals, alloys, ceramics and other inorganic compounds, plastics, and lubricants are outlined. The state of knowledge with regard to the possibility of predicting behavior is discussed for each of the material classes. The specific areas are described in which further research and gathering of engineering data are needed. The role of space experiments in the various areas is indicated. (auth)

5420 (NP-9333(Vols.I-IV)) FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). (Vol. I. 135p., Vol. II. 184p., Vol. III. 179p., and Vol. IV. 214p.).

Abstracts were prepared for 27 of 28 papers presented at the Radiation Effects Symposium on radiation effects

on aircraft equipment and structural components. An abstract had previously been prepared for one paper. (C.J.G.)

5421 (NP-9333(Vol.I)(Paper I)) REACTOR IRRADIATION OF AN/ARC-34. D. B. Howell and R. A. Thompson (Lockheed Aircraft Corp., Marietta, Ga.). Paper I of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 25p.

Irradiation tests were performed on an air-borne transceiver at the Georgia Nuclear Laboratory Radiation Effects Reactor to demonstrate the various capabilities of the laboratory. The tests were discussed relative to testing environment, article routing, irradiation and postirradiation examinations, and data analysis. The facility and its equipment were found to be adequate for accurate radiation effects testing. (C.J.G.)

5422 (NP-9333(Vol.I)(Paper 2)) NUCLEAR IRRADIATION EFFECTS ON MAGNETIC ALLOYS. E. I. Salkovitz and A. I. Schindler (Naval Research Lab., Washington, D. C.) Paper II of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 22p.

The effects of radiation on the sixty-cycle hysteresis loops of a variety of magnetic alloys were studied. For the difficult-to-order NiFe type alloys, the largest changes occurred in the remanence which decreased. For the Ni_3Fe type samples both the coercive force and remanence increased. The data indicated a similarity between thermal and radiation-induced ordering and that the two processes are additive. (C.J.G.)

5423 (NP-9333(Vol.I)(Paper 3)) INDUCED CONDUCTIVITY IN PRE-IRRADIATED INSULATING MATERIALS. Arthur Bradley, Arthur P. Pinkerton, and Stanley Grand (Radiation Research Corp., New York). Paper 3 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 24p.

Measurements of induced conductivity were made on samples of boron nitride, quartz, mica compositions, polystyrene, and glass which were electron irradiated at 10^4 rads/hr. Natural mica and Corning 1723 borosilicate glass exhibited the lowest induced conductivities of the materials tested. (C.J.G.)

5424 (NP-9333(Vol.I)(Paper 5)) A DATA ACQUISITION SYSTEM FOR THE STUDY OF TRANSIENT RADIATION EFFECTS ON ELECTRONIC DEVICES. D. O. Cochrane, F. E. Graham, H. S. Sauer, and F. I. Strabala (Edgerton, Germeshausen and Grier, Inc., Boston). Paper 5 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 16p.

A data recording system, designed for use in determining both the transient and permanent effects that an environment of the type created by a nuclear detonation or a pulsed reactor exerts on electronic devices, is described. The design of suitable test heads for containing the electronic devices is discussed. The design of a blockhouse for use near Ground Zero when evaluating components in a weapons environment is also discussed. (C.J.G.)

5425 (NP-9333(Vol.I)(Paper 6)) (REMAS) A 704 COMPUTER PROGRAM FOR HANDLING RADIATION EFFECTS INFORMATION. J. C. Mitchell and F. W. Smith (Chance Vought Aircraft, Inc., Dallas). Paper 6 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 16p.

An IBM 704 program, the Radiation Effects Machine Analysis System (REMAS), was designed to handle a large volume of data on radiation effects on materials and components. A description of the REMAS print out and report routines is given. The type of data contained on each entry is described. (C.J.G.)

5426 (NP-9333(Vol.II)(Paper 3)) RADIATION AND OTHER ENVIRONMENTAL EFFECTS ON ELASTOMERIC COMPOUNDS. E. E. Mooney and S. T. Semegen (Goodrich (B. F.) Co. Research Center, Brecksville, Ohio). Paper 3 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 75p.

The combined and separate effects of heat (158°F) and γ radiation on elastomeric compounds, both with and without radiation damage inhibitors, were studied in air and under compression in air and alkyl diphenyl ether using stress-strain and compression set measurements. Graphs are presented of percentage retention of initial elongation as a function of exposure time. Compression set is computed using a method which corrects for preirradiation set. Compression set exhibited a half life dose which is lower than that for percentage elongation loss. (C.J.G.)

5427 (NP-9333(Vol.II)(Paper 4)) GAMMA IRRADIATION OF ELECTRO-HYDRAULIC SERVO TEST LOOP USING ORONITE 8515 FLUID. E. W. Miller and A. MacCullen (Lockheed Nuclear Products, Marietta, Ga.). Paper 4 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 45p.

Gamma irradiation tests were conducted on an electro-hydraulic servo test loop operating at 275°F to determine radiation effects on loop components, the hydraulic fluid (Oronite 8515), and various Viton A seals. Tables of the properties of unirradiated and irradiated seals and Oronite 8515 are presented for comparison. (C.J.G.)

5428 (NP-9333(Vol.II)(Paper 5)) EFFECTS OF ELECTRON RADIATION ON THE THERMAL PROPERTIES OF SELECTED POLYPHENYL ETHERS. William L. R. Rice (Wright Air Development Center. Materials Lab., Wright-Patterson AFB, Ohio) and William B. Cheney, Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Paper 5 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 14p.

The effects of electron irradiation on the thermal properties of diphenyl ether, 1,4-diphenoxybenzene, and bis (p-phenoxyphenyl) ether were investigated. The samples were irradiated under a nitrogen atmosphere to a total dose of 1×10^{11} ergs per g. (C.J.G.)

5429 (NP-9333(Vol.III)(Paper 1)) LONG-TERM RELIABILITY ACHIEVEMENT AND DEMONSTRATION FOR ELECTRONIC EQUIPMENTS. Lester K. Arquette (Bendix Aviation Corp. Bendix Systems Div., Ann Arbor, Mich.). Paper 1 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 22p.

Statistical tests for determining the long-term reliability of electronic equipment in nuclear radiation environments are presented. Problems relating to the validity and economic feasibility of such test procedures are discussed. (C.J.G.)

5430 (NP-9333(Vol.III)(Paper 2)) IRRADIATION OF FABRICS AND LEATHER. Ed. F. Degering, Louis I.

Weiner, and Ludwig Seligsberger (Quartermaster Research and Engineering Center, Natick, Mass.). Paper 2 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 16p.

The effects of electron irradiation on the mechanical properties of Acrilan, aminized cotton duck, cotton duck, cotton sateen, nylons, and various treated fabrics were studied. The fabrics received dose levels of 0 to 200 megareps and were evaluated by determinations of tear strength. The effects of electron irradiation (0 to 10 megareps) on various leathers were evaluated by use of bursting strength, stitch-tearing strength, and shrinkage temperature tests. (C.J.G.)

5431 (NP-9333(Vol.III)(Paper 5)) RADIATION-RESISTANT AIRCRAFT TIRES. J. W. Born (Goodrich (B. F.) Co. Research Center, Brecksville, Ohio). Paper 5 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 60p.

Radiation effects tests were conducted on aircraft tires, half of which contained antirad protective compounds. The tires received nominal exposures of 8.39×10^9 ergs per gram (c). The conventional tire retained an average 15% of the normal test life. The antirad-protected tires retained 25% of the normal test life after receiving a 16% higher radiation exposure than the conventional tire. (C.J.G.)

5432 (NP-9333(Vol.III)(Paper 6)) RADIATION RESISTANT POLYSILOXANE ELASTOMERS. D. J. Fischer, R. G. Chaffee, and Vernon Flegel (Dow Corning Corp., Midland, Mich.). Paper 6 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 13p.

The effects of high temperature and radiation environments on polysiloxane elastomers were studied at temperatures up to 200°C. (C.J.G.)

5433 (NP-9333(Vol.III)(Paper 7)) IRRADIATION OF AN AIRCRAFT HYDRAULIC CONSTANT SPEED DRIVE. F. J. Coyle, R. L. Rio, and I. T. Berkland (General Electric Co. Aircraft Accessory Turbine Dept., Lynn, Mass.). Paper 7 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 16p.

The effects of radiation on the operation of a ball piston hydraulic constant speed drive were studied. The drive was exposed to a total dosage of 5×10^7 r. Tests conducted during and after the irradiation indicated that the drive operated satisfactorily and was unaffected by radiation. (C.J.G.)

5434 (NP-9333(Vol.IV)(Paper 1)) GAMMA IRRADIATION OF X-211 ENGINE ACCESSORY SYSTEMS. D. E. Barnett (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati) and S. L. Kalfus (General Electric Co. Jet Engine Dept., Cincinnati). Paper 1 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 32p.

Gamma irradiation tests were conducted on the fuel, lube, and hydraulic systems of an aircraft gas turbine at radiation levels of 1.2×10^6 to 2.4×10^7 ergs gm^{-1} (c)/hr for periods up to 250 hr. No serious thermal or mechanical malfunctions occurred as a result of the radiation environment. Radiation effects were observed on the organic fluids and elastomers used in test systems by changes in such properties as viscosity and neutralization number. (C.J.G.)

5435 (NP-9333(Vol.IV)(Paper 3)) THE INFLUENCE OF NUCLEAR RADIATION ON THE CORROSION OF METALS. C. L. Younger (Convair, Fort Worth, Tex.). Paper 3 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 31p.

The effect of radiation on the corrosion of metals is reviewed relative to corrosion-resistant characteristics of metals; effects of radiation on the medium and subsequent effect of corrosion of the metal; and the effect of service loads on the corrosion of metals in a nuclear environment. 31 references. (C.J.G.)

5436 (NP-9333(Vol.IV)(Paper 5)) O-RING TESTING IN MIXED FIELD IRRADIATION. E. E. Kerlin (Convair, Fort Worth, Tex.). Paper 5 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 11p.

Static radiation tests were conducted on O-ring compounds (Neoprene, Buna A, and Vitron base materials) in air at 75°F and in oil at 75 and 400°F. It was found that of the three types of O-ring compounds, those compounds formulated from a base polymer of Vitron A were least radiation-resistant. (C.J.G.)

5437 (NP-9333(Vol.IV)(Paper 6)) DESIGNING FOR MINIMUM ACTIVATION. E. L. Burkhard (Convair, Fort Worth, Tex.). Paper 6 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 26p.

A technique was devised which combines calculated alloy dose rates with a structural index (ratio of yield strength to density) to aid in the selection of an optimum material for any given application. Graphs are presented which show the variations in activation of several types of alloys, both shielded and unshielded, at temperatures of 400, 1000, and 1600°F. (C.J.G.)

5438 (NP-9333(Vol.IV)(Paper 7)) COMBINED EFFECTS OF NUCLEAR RADIATION AND DYNAMIC MECHANICAL STRESS FIELDS IN ORGANIC MATERIALS. E. G. Fritz (Convair, Fort Worth, Tex.). Paper 7 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 16p.

A theoretical analysis of the response of organic materials to the simultaneous exposure to radiation and dynamic mechanical stress fields is presented. The combined effect of both influences was found to most likely be exhibited by elastomers, explosives, organic fluids in hydrostatic and hydrodynamic systems, and fusible particles. (C.J.G.)

5439 (NP-9333(Vol.IV)(Paper 8)) RADIATION EFFECTS—A MAJOR INFLUENCE IN DESIGNING ELECTRONIC SYSTEMS FOR USE IN NUCLEAR-POWERED AIRCRAFT. J. H. Levine and W. F. Ekern (Convair, Fort Worth, Tex.). Paper 8 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 30p.

The problem of determining and combating the effects of radiation on electronic materials and components in a nuclear aircraft is discussed. Transient, permanent, and secondary radiation effects are described and examples given. Methods of radiation damage analysis, the weak-link concept and analog computer simulation, are discussed. An example of system analysis using the weakest-link concept is given. (C.J.G.)

5440 (NP-9333(Vol.IV)(Paper 9)) RADIATION EFFECTS ON AIRCRAFT PRESSURE AND FUEL TANK

SEALANTS. L. L. Morgan (Convair, Fort Worth, Tex.). Paper 9 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 26p.

Irradiation tests were conducted on sixteen types of polysulfide-base aircraft pressure and fuel tank sealants. Tensile and peel specimens were irradiated in air and fuel to a maximum of 2.5×10^{19} ergs/gm (c) γ and 1.5×10^{18} nvt (E > 0.33 Mev). (C.J.G.)

5441 (NP-9340(Vol. I)(Sect. III)) RADIATION DAMAGE. M. W. Thompson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Section III of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 33p.

Recent advances in solid-state research have provided a general picture of the mechanisms of damage which provides a model for discussing the observed effects. Fast neutrons, β radiation, γ radiation, and slow neutrons and the damage each produces are considered. The structural processes of damage are discussed. Effects in nonfissile materials, metallic fuels, and ceramic fuels are outlined. (W.D.M.)

5442 (NP-9523) EVALUATION AND DEVELOPMENT OF MIL-C-14157 CAPACITORS FOR NUCLEAR RADIATION ENVIRONMENT. Scientific Report No. 5. E. R. Pfaff (Admiral Corp., Chicago). [1960?]. 43p.

All capacitor units impregnated with uninhibited FS-5 and silicone gel dielectric impregnant and the capacitors with FC-43 dielectric fluid constituting the γ group failed in less than 63 hr. Irradiated units with Etherm "A" dielectric fluid and 4% tertiary butyl anthraquinone exhibited a slight improvement in the 75% failure point over the irradiated standard 1% inhibited units. The control group units with additional inhibitor had an appreciable improvement in the 75% failure point over the 1% inhibited units. The 75% failure point of the irradiated cross-linked polystyrene solid impregnant capacitors was reached more rapidly than for the standard units. Post-irradiation tests of the Mylar indicate that it is being damaged by hydrolytic degradation rather than by γ damage. This type of damage can be improved by isocyanate treatment of the Mylar. Dielectric properties of monoisopropylbiphenyl dielectric fluid have been improved by filtration. Capacitors are being manufactured with isocyanate treated Mylar and this improved dielectric fluid. Samica capacitors for future tests are being procured from the Scintilla Division of Bendix Aviation Corporation. (auth)

5443 (NP-9615) ANTIRADS FOR NITRILE RUBBER. (RIA-60-2856). J. W. McGarvey (Rock Island Arsenal Lab., Ill.). Sept. 22, 1960. 31p. DA Project No. 593-32-002. OTS.

The mechanisms of radiation damage and protection in organic materials were investigated and a total of 118 different nitrile vulcanizates containing potential antirads was evaluated in a screening program. Several antirads were found which imparted a significant degree of protection to nitrile rubber exposed to Co^{60} γ radiation. A good antirad such as 1,1'-diphenyl-2-picrylhydrazine imparted approximately the same degree of radiation resistance to nitrile rubber as is inherent in natural rubber. This investigation also demonstrated the existence of certain structural correlations by which it may be possible to select or synthesize new and even more efficient antirads. (auth)

5444 (ORNL-3017(p.21-35)) LOW-TEMPERATURE IRRADIATION STUDIES. T. H. Blewitt, R. R. Coltman, et al. (Oak Ridge National Lab., Tenn.).

Detailed isochronal annealing studies of copper irradiated near 4°K by fast neutrons show no annealing peaks below the main 35 to 45°K peak. Uranium-235 fission fragment damage in copper and aluminum shows exponential saturation plus a linear damage rate term with strong suppression of the 35 to 45°K peak at high damage concentrations. B^{10} fission damage in copper shows annealing peaks at low temperatures combined with continuous type annealing. Length changes in U^{235}-doped copper and aluminum bombarded at 4.5°K were measured. Subsequent isochronal annealing studies show identical fractional recovery of length change and resistivity in the case of aluminum. Similarities between fission and neutron damage are illustrated. The isochronal annealing behavior of high-purity Cu, Ag, Au, Ni, Pd, Pt, and Al were studied following neutron bombardments near 4°K. The same annealing peak structures found after electron and deuteron irradiations are not observed here. Work is in progress on modifications to the present low-temperature bombardment facility in an effort to obtain a larger sample chamber operating at 4 to 5°K. The present sample chamber is not large enough to carry out several important experiments. By using the γ-ray flux of the Oak Ridge Research Reactor as a means for homogeneously heating a sample, the stored energy associated with radiation-induced defects in copper was determined. Estimates of defect concentrations are made, assuming several defect models. The residual resistivity of several dilute copper-base alloys was found to decrease considerably upon annealing in oxygen at small pressures. The change in resistivity of a dilute nickel-in-copper alloy was much smaller after such a treatment. These observations are discussed in terms of the preferential internal oxidation of solute atoms. A study of the effect of internal oxidation on the resistance minimum in these alloys would indicate that greater caution is required in relating the presence of the minimum to the major alloying agent. The effect of internal oxidation on the residual resistivity of 99.995% gold was also investigated. The magnetic susceptibility was determined as a function of temperature and magnetic field for copper that was annealed, in turn, in a reducing and an oxidizing atmosphere. In 99.999% pure copper, oxidation caused a ferromagnetic contribution to appear. The amount of ferromagnetic material could be estimated to be a little less but of the same magnitude as the amount of paramagnetic impurity present in the reduced material. Doping copper with 0.1% iron causes the same effects to appear in such a magnitude as to make it impossible to use a sensitive susceptibility balance to obtain quantitative results. The effects seen in 99.999% pure copper can be explained if oxidation of copper causes iron, present as a trace impurity, to precipitate. (auth)

5445 (ORNL-3017(p.36-41)) DISLOCATION INTERACTIONS. D. O. Thompson, V. K. Paré, et al. (Oak Ridge National Lab., Tenn.).

By measuring the internal friction and modulus of a copper single crystal while it is being irradiated at constant temperature, it is possible to obtain a relative measure of the number of radiation defects mobile enough to diffuse to dislocation lines and pin them. These experiments are being continued. So far, defects have been found to become mobile in temperature intervals centered at 45, 160, 275, and 330°K. The last two of these account for over 90% of the observed defects. Techniques were developed to allow a sample to be held at the boiling point of nitrogen while it is being deformed and mounted in the internal friction apparatus. Preliminary measurements indicate that the method will be useful in studying the behavior of point defects produced during plastic deformation. Room-

temperature measurements of internal friction were made during irradiation at frequencies from 10 to 110 Mc, using the pulse echo method. The pinning of dislocation lines by radiation defects causes a transition from damping-limited dislocation motion to line-tension-limited motion; the variation of internal friction with irradiation time is as predicted for this case by the theory of Granato and Lücke. From the measured etch pit density and the parameters obtained in fitting the theory to the internal friction data, values are derived for the dislocation density, average line length, and damping constant. (auth)

5446 (ORNL-3017(p.61-81)) SEMICONDUCTOR STUDIES. J. W. Cleland, J. H. Crawford, Jr., et al. (Oak Ridge National Lab., Tenn.).

The variation of σ and μ_H of n-type germanium with neutron bombardment was treated on the basis of a disordered-region model of lattice damage. It is found that the bulk of the initial change in these properties can be accounted for in terms of disordered regions ~100 A in radius for the neutron spectrum employed. Nuclear reactions accompanying thermal-neutron capture in semiconductors were employed to examine (a) recoil effects, (b) chemical impurity introduction, (c) impurity compensation, and (d) time-dependent observations of electronic properties via the fixed rate of radioactive decay. Recoil effects following thermal-neutron capture were investigated in 95.8%-enriched Ge^{74} samples. Vacuum anneal subsequent to irradiation was also employed to examine the donor action of the As^{75} introduced by transmutations. Application of the "replacement-collision" model to these results is discussed. Annealing studies of Co^{60}-irradiated antimony-doped n-type germanium revealed a complex annealing process in which the impurity atoms present have a major role. Measurements of mobility and carrier concentration indicate that the ionized defect first migrates to an impurity and is then released before its final removal. The thermoelectric power in germanium was measured with increased attention to eliminating contact effects and experimental errors. Emphasis was placed on measurements at differential temperatures less than 1°C. The effect of fast-neutron irradiation, thermal-neutron irradiation and subsequent transmutation introduction of chemical impurities, and thermal annealing was investigated for n-type germanium that was chemically doped with donor-type tellurium. It is shown that fast-neutron-induced disorder introduces defect states or disordered regions that remove or compensate the tellurium donor impurity upon vacuum anneal. An experimental survey employing minority-carrier lifetime was made of the annealing above room temperature of recombination centers induced by 14-Mev monoenergetic neutrons, fission neutrons, and Co^{60} γ rays. In each case three specimens were used of the following type and resistivity: 2-ohm-cm p-type, 2-ohm-cm n-type, and 15-ohm-cm n-type. A large difference in the annealing behavior was observed among the three types of radiation damage as well as the three types of specimens. More detailed studies are now in progress, including the effect of different impurities. Bombardment of germanium with with 3.98×10^{20} nvt_f produces a measured volume expansion of 0.77% and a calculated x-ray volume expansion of 0.46%, indicating the production of vacancies by neutron irradiation. Unexpectedly one test showed an increase in hardness in a sample irradiated in this way. Hall coefficient measurements were continued on n-type silicon containing varying amounts of oxygen. It was found that, in addition to a net acceptor level located 0.17 ev below the conduction band, a level close to 0.5 ev below the conduction band is introduced. The introduction of the deep level is highly sensitive to the oxygen content and apparently also to the original resistivity of the samples. The electrical conductivity of two cuprous oxide samples was studied as a function of temperature, of pressure, and of electrical contact to the sample. The conductivity below ~300°C is sensitive to time at room and elevated temperatures and to pressure. Little difference has been noted between a silver-plated contact and a gold-foil pressure contact. (auth)

5447 (ORNL-3017(p.89-96)) COVALENT CRYSTALS. R. A. Weeks, C. M. Nelson, et al. (Oak Ridge National Lab., Tenn.).

Hyperfine interactions of the E_1' center with five Si^{29} nuclei have been observed. The interactions produce hyperfine lines whose separation is 404, 8.0, 6.8, 0.6, and ~0.4 oersteds for [00.1] parallel to H, the applied magnetic field. These results show that the model that has been suggested is not a good one. Another possible model is suggested. An inverse ratio is established between the concentration of hydrogen, determined by the intensity of the O-H stretching mode, and the concentration of the E_1' center, produced by a Co^{60} γ-ray dose of ~10^6 r, in several silicas. In the silica with the least hydrogen, the concentration of the E_1' center is observed to be ~1.7×10^{19} cm^{-3} for an x-ray dose of ~10^9 rads if the irradiation and measurement are carried out at 78°K without intervening warm-up. No saturation of concentration is evident. It is suggested that the E_1 center is a fundamental characteristic of the silica structure. Observations at room temperature on neutron-irradiated TiO_2 single crystals showed a complex ESR spectrum. One set of lines, having $g_{obs} = 1.986$ and $g_{obs} = 1.991$, was observed as a function of orientation of the crystal with respect to H, the applied magnetic field. An analysis of the data suggests that there may be two centers, one with spin $S = \frac{1}{2}$ and the second with spin $S = 1$. (auth)

5448 (ORNL-3017(p.97-100)) GRAPHITE AND CERAMICS. M. C. Wittels and F. A. Sherrill, et al. (Oak Ridge National Lab., Tenn.).

Preannealing colorimetric studies of X-10 pile graphite show confirmation of previous stored-energy growth rates, importance of low-temperature annealing, lack of significant damage in the moderator 4 ft west of center, and a slow buildup of damage near the center of the reactor moderator. The temperature for the dehydration of asbestos is lowered by reactor irradiation. The weight-loss–temperature relation is insensitive to the rate of heating at rates in the range from 50 to 500°C/hr. The effect of irradiation on the dehydration of muscovite mica was studied kinetically. Both the activation energy and the Arrhenius factor are decreased by irradiation. (auth)

5449 (ORNL-3017(p.109-15)) HIGH-TEMPERATURE FUEL MATERIALS. O. Sisman, J. G. Morgan, et al. (Oak Ridge National Lab., Tenn.).

Evaluation studies on the irradiation behavior of reactor fuels were continued during the past year, with emphasis on UO_2 and the EGCR first fuel loading. Fission gas release data were obtained with varying density, temperature, stoichiometry, and burnup. Microstructural changes were observed at the higher temperatures. Dispersions of UC_2 in graphite and graphite coatings were also investigated as a part of the GCR advanced materials studies. An in-pile experiment is being used to study the continuous evolution of fission gas under varying conditions of temperature, power density, and burnup for a variety of fuel materials. A large increase in fission gas release was observed for

UO_2 which was oxidized during irradiation. During the period of irradiation (1.2×10^{20} nvt), the thermal conductivity of the UO_2 did not change. (auth)

5450 (AAEC/Trans-3) THE INFLUENCE OF CORPUSCULAR RAYS ON THE CREEP BEHAVIOUR OF METALLIC MATERIALS. G. Saur, H. Laue, and H. Borchers. Translated by K. E. Cecers from Atomkernenergie 4, 98-104(1959). 15p.

Difficulties of experiments on the influence of radiation on creep in metals are discussed. Some typical apparatuses for investigation by using sources such as reactors and cyclotrons, are described. These methods have resulted in relatively inaccurate measurements. Therefore, the published results do not allow any statement of laws, but only tendencies. There is a surprising influence of charged particles on creep rate in spite of their low depth of penetration. The discussion of the results leads to the conclusion that the temperature of the specimen, the stresses, and the density of beam are very important. Two requirements are put forward for such researches if they are to be of technical importance. (auth)

5451 THE INFLUENCE OF NEUTRON RADIATION ON THE FINE CRYSTAL STRUCTURE AND PROPERTIES OF METALS AND ALLOYS. I. V. Batenin, V. A. Il'ina, V. K. Kritskaya, G. V. Kurdyumov, and B. V. Sharov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR and Bardin Central Scientific Research Inst. of Ferrous Metals, [USSR]). Doklady Akad. Nauk S.S.S.R. 134, 802-5(1960) Oct. 1. (In Russian)

The influence of 10^{20} to 10^{21} neutrons/cm^2 irradiation on Fe, Cu, Fe + 4 at. % Ni, Fe + 0.6 at. % W (Fe and Fe–Ni were annealed at 600, Cu at 400, and Fe–W at 650°C) was investigated. The obtained data were used for determining the character of structural changes and the causes of some property changes (microhardness). (R.V.J.)

5452 EFFECT OF REACTOR IRRADIATION ON THE TENSILE STRENGTH OF UNIAXIALLY ORIENTED POLYETHYLENE TEREPHTHALATE. C. C. Hsiao and S. T. Chow (Univ. of Minnesota, Minneapolis). J. Appl. Phys. 31, 1869-71(1960) Nov.

A series of irradiated uniaxially oriented polyethylene terephthalate fibers were investigated. On the basis of tensile studies the ultimate tensile strength is found to decrease as the dose of irradiation increases. The ultimate tensile strength is found to increase when the degree of molecular orientation increases. But after the samples have received a relatively high dose of irradiation the tensile strength approaches practically zero. The x-ray diffraction scans of the nonirradiated samples with low degrees of orientation indicate very little crystallinity, whereas the very definite diffraction peaks associated with the irradiated and oriented samples indicate a definite trend toward crystallinity. (auth)

5453 EFFECT OF TEMPERATURE AND REACTOR IRRADIATION ON THE STRENGTH OF BIAXIALLY ORIENTED POLYETHYLENE TEREPHTHALATE. A. Haynes and C. C. Hsiao (Univ. of Minnesota, Minneapolis). J. Appl. Phys. 31, 1871-3(1960) Nov.

Samples of irradiated biaxially oriented polyethylene terephthalate were investigated at five temperature levels from –150°F to 350°F. From tensile studies, the ultimate tensile strength was found to decrease markedly to a relatively low magnitude upon receiving an irradiation dose having a thermal neutron bombardment component of 10^{18} nvt and over. The modulus of elasticity for both the irradiated and nonirradiated samples was found to increase with the decrease of the temperature. The fracture surfaces of the biaxially oriented polyethylene terephthalate samples obtained at –15°F are recorded for reference. (auth)

5454 EFFECT OF NEUTRON BOMBARDMENT ON THE MAGNETIC PROPERTIES OF VERY HIGH PERMEABILITY IRON. G. Biorci, A. Ferro, and G. Montalenti (Centro Studi per l'Electtrofisica, Turin). J. Appl. Phys. 31, 2046-7(1960) Nov.

Rings of iron with permeability of about 150,000, after neutron bombardment (1×10^{18} nvt), show lower permeability and higher coercive force. This effect can be interpreted as due to large defects giving long-range internal stresses, or as due to anisotropic defects interacting with the magnetization vector at each point of the specimen. (auth)

5455 ON THE VISCOSITY OF IRRADIATED POLYMERS. III. EFFECT OF BRANCHING. Kanji Katsuura (Tokyo Univ.). J. Phys. Soc. Japan 15, 2310-17(1960) Dec. (In English)

The intrinsic viscosity of an irradiated polymetric substance is calculated with inclusion of the effect of branching. The contribution of a branched polymer to the intrinsic viscosity is evaluated according to Debye-Bueche's theory with some modifications. The distribution of molecular size and crosslink unit is obtained through an extension of Saito's theory. The results agree with experiment fairly well. The essential reason for the large discrepancy between Saito's calculation and experiment is shown to be his neglect of branching. (auth)

5456 OPTICAL BLEACHING OF GAMMA-IRRADIATED KCl AT ROOM TEMPERATURE. Noriaki Itoh and Tokuo Suita (Osaka Univ.). J. Phys. Soc. Japan 15, 2364(1960) Dec. (In English)

An investigation was made of the effects of bleaching temperature and initial concentration of F centers on the bleaching phenomena in γ-irradiated KCl. From the bleaching curves at 18 and –25°C for specimens irradiated to various dosages, the concentration N_q of quickly bleaching F centers was obtained. The dependence of N_q on the γ dosage for the two bleaching temperatures is graphically illustrated. For dosages less than 3×10^5 r, there is no difference in N_q for the two bleaching temperatures. The dependence of the ratio of N_q at –25°C to the initial concentration N_F of F centers on the γ dose is shown. The results seem to show that the quickly bleaching component of F centers at room temperature is composed of two parts. The one related to complex center formation increases with bleaching temperature; the other is independent of bleaching temperature. The latter may be caused by recombinations of electrons with positive holes at some hole trapping centers that have larger cross sections for electron trapping than those that correspond to more stable F centers. The formation mechanism of F centers in the early stage seems to be different from that in the later stage, which may cause the differences in the trapping states of positive holes recombining with electrons from F centers. (B.O.G.)

5457 EFFECTS OF GAMMA RADIATION ON SOME ELECTRICAL PROPERTIES OF TFE-FLUOROCARBON PLASTICS. W. E. Loy, Jr. (Martin Co., Baltimore). p.68-78 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The measurements of several dielectric properties of TFE-fluorocarbon (Teflon) plastics before, during, and

after γ irradiation by a Co^{60} source are reported. Postirradiation measurements of dielectric constant of 32- and 125-mil specimens, irradiated to a dose of 5.7×10^7 r, indicated no change from the preirradiation values. Dielectric strengths of 3-, 5-, and 11-mil specimens, irradiated to a dose of 5.7×10^7 r, did not change significantly from the preirradiation values. Volume resistivity of specimens irradiated at dose rates ranging from 3×10^2 r/hr to 1.85×10^5 r/hr decreased very rapidly during irradiation. After approximately 20 hr resistivity reached a constant value which was at least a factor of 10^3 below the preirradiation value. Results indicate that the resistivity during irradiation is an inverse function of dose rate and specimen thickness. After the removal of 4- and 8-mil specimens from the irradiation field, resistivity increased steadily toward the preirradiation value. The postirradiation resistivity of 250-mil specimens increased exponentially for approximately 8 hr after which a gradual decrease was observed for several hundred hours. Postirradiation values of resistivity indicate a dependence on the dose to which a specimen was irradiated. (auth)

5458 IRRADIATION OF SOME PRESSURE-VESSEL STEELS. L. P. Trudeau (International Nickel Co. of Canada, Ltd., Toronto). p.102-15 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The results of a neutron irradiation study of mechanical properties are reported for a number of pressure vessel steels and high-strength steels of possible future interest. The irradiations were carried out in the NRX reactor with a flux of 3.1×10^{13} neutrons/cm^2/sec at 120 to 160°F, although a few high-temperature irradiations were made with a flux of 1.9×10^{13} neutrons/cm^2/sec at 425 to 700°F. Graphs of the radiation effects on the notch impact properties are presented, and a thorough discussion of the implications of the results is given. (D.L.C.)

5459 DYNAMIC RADIATION EFFECTS TESTING METHODS. D. M. Newell, E. E. Kerlin, R. R. Bauerlein, and R. F. Barrows (Convair, Fort Worth, Tex.). p.137-46 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Studies of radiation effects on polymers being conducted at the Convair-Fort Worth Nuclear Facility include engineering tests and fundamental research. The engineering tests are divided into two broad categories, dynamic and static. While both static and dynamic tests are necessary, dynamic tests give results which provide a better basis for the interpretation of changes with respect to the application of the material. Dynamic tests also supply valuable data in the support of fundamental research and development of new materials. However, some electrical problems arise when dynamic tests are conducted in a reactor field. The radiation field can cause errors in electrical signals through either temporary electrical effects or permanent radiation damage to the test apparatus. The dynamic test assembly must be designed to avoid these problems or minimize the errors. The three dynamic tests described were designed for the determination of (1) stress relaxation of rubber, (2) the modulus of rigidity of honeycomb sandwich panels by the plate shear method, and (3) the dynamic modulus of elasticity of rigid plastics by the resonance method. Some of the theory, a description of the test gear, and an interpretation of the results of tests performed thus far are presented. (auth)

5460 RADIATION EFFECTS IN STEEL. Lew F. Porter (U. S. Steel Corp., Monroeville, Penna.). p.147-96 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

A survey is presented on the published literature on the effect of neutron radiation on the mechanical properties of steels. On theoretical grounds and on the basis of fundamental experiments it is postulated that clusters of radiation-produced vacancies or interstitials, by interacting with dislocations already present and additional dislocations produced during plastic deformation, are primarily responsible for the increased strength and decreased ductility of irradiated metals. From a tabulation of the existing information on the effect of neutron radiation on the mechanical properties of carbon, alloy, and stainless steels, it appears that relations between the changes in properties and neutron exposure can be defined. These relations indicate that steels behave in general as a class of material and are affected by neutron radiation in a similar manner so that the effects of a given neutron exposure can usually be predicted within rather general limits. Normally, a large proportion of the radiation-produced crystal lattice defects responsible for the changes in mechanical properties in steels can be removed by heating in the range 550 to 900°F. Likewise, irradiation at temperatures above 500°F usually results in less damage than irradiation at lower temperatures, presumably because of concurrent thermal annealing of the damaged regions. Under certain conditions, radiation may accelerate phase transformation or aging phenomena, and changes in mechanical properties as a result of such secondary effects may not be removed by the annealing treatments at 550 to 900°F. It is important to recognize that the above generalizations are based on results which show considerable scatter and that there is information available which indicates that such factors as grain size, microstructure, composition, and steel cleanliness can influence the magnitude of the radiation effect. (auth)

5461 THE SIGNIFICANCE TO ASTM OF POSTIRRADIATION EFFECTS IN IRRADIATED MATERIALS. D. S. Ballantine (Brookhaven National Lab., Upton, N. Y.). p.201-7 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960. (BNL-4408)

Experimental evidence of long-lived trapped free radicals persisting after irradiation are reviewed, e.g., electron spin resonance spectra, crosslinking of polyethylene by postirradiation heating, postirradiation oxidation, and graft copolymerization. It is concluded that, since radio-induced free radicals in organic polymers continue to react after irradiation and thus causes physico-chemical changes with time, research in this area is needed to develop an ASTM practice for uniform irradiation and postirradiation treatments. (D.L.C.)

5462 ELECTRON SPIN RESONANCE STUDIES OF FREE RADICALS IN IRRADIATED MATERIALS. Leo A. Wall (National Bureau of Standards, Washington, D. C.). p.208-23 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Data are reported on the electron spin resonance spectra of N_2, N_2^{15}, CH_4, H_2, and D_2 irradiated at 4.2°K and of polystyrene, polytetrafluoroethylene, and a tetrafluoroethylene-hexafluoropropene copolymer irradiated at 300 and 77°K. (D.L.C.)

5463 POSTIRRADIATION OXIDATION AND MOLECULAR WEIGHT CHANGES IN POLYSTYRENE AND POLY (METHYL METHACRYLATE). W. W. Parkinson and D. Binder (Oak Ridge National Lab., Tenn.). p.224-32 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Polystyrene and poly(methyl methacrylate) were irradiated and the oxidation of polystyrene on exposure to air determined from infrared spectra. The molecular weight changes in both polymers were determined from their viscosity in solutions. For polystyrene, no change in its molecular weight was observed, while that of poly(methyl methacrylate) decreased with time. The results are fully discussed together with several possible mechanisms for explaining them. (D.L.C.)

5464 POSTIRRADIATION DIELECTRIC PROPERTIES OF SILICONES. C. G. Currin (Dow Corning Corp., Midland, Mich.). p.233-43 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

The dielectric constant, dissipation factor, resistivity, and electric strength of seven representative silicones were measured over an extended period following γ irradiation to a dose of 4 to 5 Mrad at 25 and 150°C. The dielectric constant and electric strength of all samples remained constant during this period, while both resistivity and dissipation factor often increased, but not enough to affect their performance as insulation. Most of these postirradiation effects took place in the first hour, although some were observed 10 hr after the irradiation. A possible mechanism for these effects is suggested. (D.L.C.)

PHYSICS

General and Miscellaneous

5465 (AECU-4654) AN EVALUATION OF THE FACTORS INFLUENCING THE STABILITY OF A LARGE UNDERGROUND CAVITY. Don U. Deere. Includes Appendices: I. STRESS CONCENTRATION FACTORS IN AN ELASTIC MEDIUM. H. L. Langhaar and A. P. Boresi. II. DEPTH OF PLASTIC ZONE. H. L. Langhaar and A. P. Boresi (Illinois. Univ., Urbana). Nov. 15, 1959. 85p. OTS.

The factors that influence the state of stress surrounding a deep underground cavity are discussed and evaluated relative to their effects on the stability of a cavity in granite, salt rock, or other hard rock. The importance of knowing the initial state of stress in the rock and of the presence of geologic discontinuities is discussed. A theoretical analysis of the stress distribution around various shaped cavities in an elastic medium is presented. The depth of the plastic zone developed around cavities under certain conditions is studied. (C.J.G.)

5466 (AERE-M-743) SOME SPECTRAL LINES SUITABLE FOR USE IN URANIUM ISOTOPE ABUNDANCE MEASUREMENTS. E. W. T. Richards (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1960. 15p.

An analysis was made of suitable spectral lines in the region 3500 to 5500 A for use in determining the isotopic composition of uranium by optical spectroscopy. (C.J.G.)

5467 (AFOSR-TR-60-111) NEUTRON AND X-RAY DIFFRACTION STUDIES OF SOLIDS. Technical Report No. 5. C. G. Shull (Massachusetts Inst. of Tech., Cambridge. Structure of Solids Group). Jan. 1, 1960. 28p. Contract AF18(603)-84.

The design characteristics of the three neutron diffraction spectrometers (single crystal analysis, polycrystalline specimen, and polarized beam units) which have been constructed are discussed. A description is given of the monochromating crystal studies and the intensity and resolution studies on the spectrometers which have been performed. Research studies which have been carried out by project personnel are summarized. (auth)

5468 (ANL-6190) PHYSICS DIVISION SUMMARY REPORT FOR JULY–AUGUST 1960. (Argonne National Lab., Ill.). 27p. Contract W-31-109-eng-38. OTS.

In a study of nuclear resonance absorption of γ rays, calculations were carried out to determine the effect on Zeeman lines of applying a resonant r-f field. Thirty-two γ rays from Er^{161}, produced by (n,2n) and (γ,n) reactions, were measured and fitted into a decay scheme. Spin and parity assignments of some levels are indicated. Results from molecular beam studies are presented for Ho^{166} and Ge^{71} In the program for $Ar^{40}-K^{40}$ dating of meteorites, a method was developed for pumping down atmospheric cutoffs, Toepler pumps, and other apparatus without carefully matching pumping rates. (For preceding period see ANL-6169. For subsequent period see ANL-6214.) (W.D.M.)

5469 (BNL-628) STATUS OF DIRECT CONVERSION PROGRAMS IN THE UNITED STATES WITH SPECIAL EMPHASIS ON CIVILIAN NUCLEAR POWER. William A. Robba (Brookhaven National Lab., Upton, N. Y.). May 1960. 13p. OTS.

A survey is presented of the current status of developments in the field of direct conversion, with emphasis on applications to civilian nuclear power plants. Thermoelectrics, thermionics, magnetohydrodynamics, and fuel cells are considered, and a brief description is given of the principles of each technique. Nuclear potential is evaluated in the light of the present stage of development. (auth)

5470 (HE-150-162) SOME PRELIMINARY RESULTS ON THE SEPARATION OF GASEOUS COMPONENTS IN A JET. J. W. Eerkens, B. Sehgal, and L. Grossman (California. Univ., Berkeley. Inst. of Engineering Research). June 2, 1958. 17p. Project No. 35. Contract AT(11-1)-34. OTS.

Preliminary experimental findings are presented on the separation of nitrogen and oxygen in a freely expanding supersonic air jet. It was found that separation was quite high in an annular region that comprised the diffuse shock close to the boundary of the supersonic core. The stagnation pressure of the jet was found to peak considerably in this shock region, thus explaining the high degree of separation there. (auth)

5471 (MND-P-2335) INTERIM REPORT ON SAFETY PROCEDURES FOR THE TASK 2 THERMOELECTRIC GENERATOR. L. T. Klein (Martin Co. Nuclear Div., Baltimore). Mar. 15, 1960. 62p. Contract AT(30-2)-217. OTS.

Operational hazards associated with the use of a radioisotope-fueled auxiliary power unit for a satellite mission are evaluated. The entire fabrication-to-flight and/or retrieval and disposal sequence is examined and safe handling procedures suggested. The design and operation of the Task 2 thermoelectric generator is discussed. (C.J.G.)

5472 (MND-P-3012-II) SNAP PROGRAMS. Quarterly Progress Report No. 4 [for] July 1 through September 30, 1960. Subtask 5.3 and Task 6. R. Harvey and W. M. Bowes, eds. (Martin Co. Nuclear Div., Baltimore). 170p. Contract AT(30-3)-217. OTS.

Generator 2A, the design of which was completed last quarter, was fabricated and electrically tested. The generator met all significant design requirements with the exception of the collector work function. During the preparations for environmental tests one of the leadthroughs failed. Metallographic examination revealed that it is necessary to make some design revisions of the leadthrough. Generator 2A was an experimental unit which led to the design of generator 2B. Specifically, the conclusions obtained from 2A confirmed certain processing methods applicable to future units. The latter unit includes provisions for remote control fueling, and its operation should attain anticipated performance characteristics (P_o, η, w, ϕ_c, T_e, T_c and life). Critical areas of design, construction, and processing of 2B include the facility for remote control fueling, the attainment of close interelectrode spacing and low collector work function, and the achievement of a rugged generator. Accordingly, a vigorous theoretical and experimental approach was undertaken. A life test on generator 1A was initiated and over 2100 hr of operating time was accumulated. The emitter was not aged prior to incorporation into the generator; as a result, the evaporation of barium from the emitter eventually reduced the diode internal resistance to the point where it was no longer feasible to continue the life test. The procedures for fueling a thermionic generator with a Cm^{242} heat source were established. An activation device in which a work function of approximately 1.9 volts was achieved was designed, fabricated, and tested. These same techniques can be incorporated in a practical generator design. Following this test, the preliminary design of generator 2B was established, and development on the design was initiated. To date, considerable progress has been made in the development of purification processes for gram quantities of americium and curium. Design, fabrication, and installation of experimental equipment for producing capsules for irradiation, for processing the capsules after irradiation, and for testing containment materials has been completed, and the equipment is in operation. The processes involved are being rigorously evaluated in preparation for the construction of prototype systems. Nuclear, thermal, and hazards analyses were undertaken on all phases of this task; results appear quite satisfactory. (For preceding period see MND-P-3011.) (auth)

5473 (NP-9333(Vol.I)(Paper 4)) ATTENUATION OF ELECTROMAGNETIC ENERGY THROUGH THE IONIZED CLOUD SURROUNDING AN AIRBORNE REACTOR. W. A. Greenhow and F. W. Smith (Chance Vought Aircraft, Inc., Dallas). Paper 4 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 19p.

A theoretical analysis of the electromagnetic energy attenuation through the ionized cloud surrounding an airborne reactor was made to determine communications power losses. The results show that power losses should not amount to more than one db for VHF for an air-borne reactor operating at power levels less than 800 ms if the antenna is located at least 10 ft from the reactor. Reflection of electromagnetic energy from the ionized region was not significant except at the very low end of the frequency spectrum which is below frequencies considered for use in telemetry systems. 25 references. (C.J.G.)

5474 (NP-9333(Vol.II)(Paper 1)) A METHOD FOR THE ANALYSIS OF ACTIVATION FOIL DATA. Hermann J. Donnert (Chemical Warfare Labs., Army Chemical Center, Md.). Paper 1 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 21p.

A method is proposed for the analysis of foil activation data. The method is based on an equation which states that the neutron flux per unit energy inducing the transmutation, $\phi(E)$, is equal to a trial function, $\phi(E)$, resembling $\phi(E)$ as closely as possible plus the summation from neutron different foil materials of their foil activation cross sections times expansion coefficients relating to the cross sections. $\phi(E)$ should approximate the differential energy spectrum, $\phi(E)$, as closely as possible. (C.J.G.)

5475 (NP-9395) THE STRUCTURE OF AN ELECTROMAGNETICALLY DRIVEN SHOCK. Vernal Josephson and Richard W. Hales (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Sept. 15, 1960. 33p. Contract AF04(647)-309. (STL/TR-60-0000-19313).

A diagnostic study of shocks produced by an electrically driven conical shock tube showed that high velocity (30-100cm/μsec) ions are accelerated out ahead of the luminous shock front by high electric fields generated by "sausage" instabilities in the conical discharge tube. It was found that the high velocity luminous front is produced by the sequential pinching of the hot ionized gas along the axis of the discharge tube, in contrast to "current loop" driven shocks in conventional T-tube discharge configurations. (auth)

5476 (NP-9494) VERSTUIVING VAN KOPER BIJ BESCHIETING MET IONEN VAN 5-25 KEV. (Sputtering of Copper by Bombardment with Ions of 5 to 25 Kev). (thesis). Pieter Klaas Rol (Amsterdam. Universiteit). 1960. 78p.

After a historical survey of experimental and theoretical work, the experimental setup is described. An electromagnetic separator is used, and its advantages and modifications are discussed. Experimental results are given for copper sputtering by the positive ions of 24 elements. In general, the sputtering ratio increases with increasing energy and ion mass. Dependence of the sputtering ratio on angle of incidence was studied for some elements with the finding that the increase is sharp for oblique incidence. The sputtering effect of N_2^+ and KI^+ ions was also investigated. Agreement of these results with existing theories is poor. The experimental results can be explained, for the most part, when it is assumed that the sputtering ratio is proportional to the energy dissipation by the impinging particle in the first atomic layers. This energy can be calculated from the mean free path of the ions in the lattice and the mean energy transferred in a collision. For the theory offered, it is assumed that the sputtered particles originate from an excited region near the surface, but the excitation mechanism is not further investigated. (T.R.H.)

5477 (NP-9548) ETUDE SYSTEMATIQUE DE SOURCES DE NEUTRONS FROIDS. (Systematic Study of Cold Neutron Sources). W. Van Dingenen and S. Hautecler (Brussels. Centre d'Étude de l'Énergie Nucléaire). [1960]. 31p.

Presented at the International Atomic Energy Agency Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, October 11-14, 1960.

Research is described which was to study and evaluate the factors on which the yield of a cold neutron source depends. The temperature, dimensions, and chemical nature

of the moderator are the parameters involved. It was found that the moderation consists in an integral displacement of the thermal neutron spectrum toward the low energies; the shape of the spectrum is only slightly changed. The average apparent temperature of neutrons decreases almost linearly with moderator temperature. An absorber in the moderator displaces the spectrum toward higher energies and at the same time lowers the total flux by an exponential factor. For a moderator with good slowing-down power the spectrum shows only cooling and no intensity increase up to a very definite volume. Displacement of the spectrum by moderation depends on the chemical nature of the moderator. (T.R.H.)

5478 (NP-9610) PHOTOVOLTAIC CELLS. Maureen Pearcy, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Aug. 11, 1960. 45p. (SB-60-28) OTS.

A bibliography of 136 references on photovoltaic cells is presented. Eleven sources were consulted in the compilation. (J.R.D.)

5479 (NP-9620) PROCEEDINGS OF THE ATOMIC AND MOLECULAR BEAMS CONFERENCE, JUNE 20-22, 1960. (Denver. Univ. [Denver Research Inst.]). 383p.

Twenty-six papers given at a conference in Denver, Colo., June 20-22, 1960, on atomic and molecular beams are presented. The principal areas of interest were extranuclear in nature, consisting of gas-gas and gas-surface effects. (W.D.M.)

5480 (NP-9622) FURTHER NOTE ON AIRFOIL THEORY IN HYDROMAGNETICS. Technical Report No. 39. G. S. S. Ludford (Brown Univ., Providence). Dec. 1960. 6p. Contract Nonr 562(07).

Lift loading on a thin airfoil moving at right angles to an applied magnetic field in a fluid of infinite electrical conductivity is investigated. The object of this work is to point out that the three basic integrals I_1, I_2, and I_3, which were expressed in terms of hypergeometric functions, are in fact simple algebraic functions; and to show that this leads to results comparable in simplicity to those in ordinary airfoil theory. (W.L.H.)

5481 (NP-9624) INFRARED SPECTRA OF URANIUM COMPOUNDS AND THE CHARACTERISTIC FREQUENCIES OF THE URANYL ION. Research Report 6-94602-9-R12. J. H. Lady and R. E. Adams (Westinghouse Electric Corp. Research Labs., Pittsburgh). July 31, 1957. 36p.

The absorption spectra of eighteen uranyl and uranium compounds and the spectra of several other related compounds in the 2 to 15.5 μ region are presented. The characteristic frequency of the UO_2^{2+} group generally occurs in the 10.5 to 10.8 μ region for uranyl compounds, uranyl chloride being the only exception of the compounds examined. Uranium dioxide, U_4O_9, and U_3O_7 show no characteristic absorption bands in the 2 to 16 μ region. The other oxide type compounds, such as uranium trioxide and peroxide, U_3O_8, and the uranates and diuranates, show bands similar to those observed in the uranyl compounds; however, the frequencies are usually shifted to longer wave lengths. One possible explanation for the frequencies observed in the oxide compounds is that they arise from the partial existence of the uranyl ion in the crystal lattice of these compounds. (W.L.H.)

5482 (NP-9626) ABSTRACTS OF PAPERS PRESENTED AT THE NASA SYMPOSIUM ON THE THEORY AND MECHANISM OF DIFFUSION IN SOLIDS, OCTOBER 24–25, 1960. (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). 35p.

Eleven abstracts are presented of the papers presented at the NASA Symposium on the Theory and Mechanism of Diffusion in Solids. (W.L.H.)

5483 (NP-9627) THEORY OF ELECTRON DRIVEN SHOCK WAVES. R. G. Fowler and B. D. Fried (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Sept. 16, 1960. 17p. (STL/TR-60-0000-GR310).

Previous calculations of the time required for ion heating in the discharge or driver section of an electrical shock tube yielded values much greater than that in which formation and acceleration of the first luminous front is observed to occur. The model of an electron driven shock is presented which shows that the relation between shock velocity, V, and electron temperature, T_e, remains valid even though the conventional picture of a shock driven by hot ions must be abandoned. Thermal expansion of the hot electron gas accelerates the cold ions, resulting in a shock front or moving electrostatic double layer. Assuming conditions behind the shock to be coupled to those in the discharge region through a simple rarefaction wave, it is found that MV^2/kT_e is a universal function of W/MV^2, where W is the effective ionization potential. This is shown to be in excellent agreement with a wide variety of experimental data. (auth)

5484 (NP-9630) RESEARCH IN THE VACUUM X-RAY REGION FROM 3 TO 20 ANGSTROMS. Final Report [for Period] November 1, 1946–August 31, 1960. (Washington State Univ., Pullman). 16p. Project Nos. NR-015-101 and NR-017-603. Contract N6-ori-167.

A brief summary of research work carried out is given and a paper on fine structure of the K x-ray absorption edge of germanium is included. (W.D.M.)

5485 (ORO-332) RESEARCH STUDIES WITH A 1-MEV VAN DE GRAAFF MACHINE. Annual Report. Frank L. Hereford (Virginia. Univ., Charlottesville). June 1960. 17p. DA Project No. 5B99-01-0001. Contracts AT(40-1)-1754 and DA-36-034-ORD-2046. (AD-239923). OTS.

The polarization of 3.4-Mev neutrons elastically scattered by sulfur, copper, and zinc was measured for scattering angles between 30 and 140°. The internal magnetic field in a ferromagnet was determined by measuring the change in the vertical component of polarization of a beam of polarized 3.4-Mev neutrons that had passed through magnetized iron. Development and use of a μsec neutron time-of-flight spectrometer are discussed. (W.D.M.)

5486 (ORNL-3017(p.3-6)) THEORY OF DISLOCATIONS. O. S. Oen, D. K. Holmes, and M. T. Robinson (Oak Ridge National Lab., Tenn.).

The decrement and change in modulus due to dislocation line motion were calculated, using a vibrating string model having no inertia and a damping force proportional to the velocity. The calculations were made for both exponential and delta function distributions of loop length. (auth)

5487 (ORNL-3017(p.7-18)) THEORY OF RADIATION DAMAGE. H. C. Schweinler, J. H. Barrett, et al. (Oak Ridge National Lab., Tenn.).

A theoretical expression is derived for the spatial rate of energy loss of a charged particle moving through a valence or ionic crystal and for the spatial rate of production of hole-electron pairs. A method was developed for calculating electron transport properties in a strong magnetic field with a temperature gradient as the driving force. Landau wave functions for free electrons in a magnetic field were used. Laplace transforms were used to solve the differential equation for the density matrix in the Landau

representation. The density matrix can be used to calculate expectation values for the velocity operator. The fast-neutron flux was computed, using a homogeneous model reactor to obtain the energy dependence and a simplified heterogeneous model to obtain the spatial variation. The results are in reasonable accord with available experiments in the ORNL Graphite Reactor. (auth)

5488 (ORNL-3017(p.82-8)) ALKALI HALIDES. F. W. Young, J. H. Crawford, Jr., et al. (Oak Ridge National Lab., Tenn.).

One mechanism for the creation of defects in alkali halides by ionizing radiation requires the evaporation of vacancies from dislocation jogs. Hence, dislocation climb would be expected if this mechanism operates. No climb was detected in Co^{60} γ-irradiated NaCl, which could account for the extent of defect production as indicated by the production of F centers. Studies were made of the optical behavior of an absorption band in x-irradiated calcium-doped KCl. The center responsible for this band was identified as a Cl_2^- molecular ion, one component of which occupies a cation vacancy. The behavior of this band under various treatments suggests that it is converted into a Cl_3^- molecular ion by ionization. Measurements of the magnetic susceptibility of alkali halides at low temperatures were started with the hope of determining oscillator strengths and other properties of color centers. Results to date on KCl indicate that uncolored material supplied by Harshaw and Isomet contains less than 10^{16} magnetic centers per cubic centimeter. Additive coloration, producing F centers, causes the appearance of magnetic centers. Annealing at 120°C to produce the colloid band causes the major part of the low-temperature paramagnetism to disappear. Some preliminary results on CsBr indicate that, in this compound too, coloration produces magnetic centers. The temperature dependence of the magnetic susceptibility of K_2ReBr_6 was measured between room temperature and 5°K. A magnetic phase change occurs at 15.5°K. Apparently the material is antiferromagnetic at low temperatures. (auth)

5489 (ORNL-3017(p.104-5)) DOSIMETRY STUDIES. D. Binder and W. K. Kirkland (Oak Ridge National Lab., Tenn.).

Fast-flux measurements with threshold and resonance reactions are tabulated for Holes A, 19, 51, 52, and 1768. The relative yield for the ceric-to-cerous reaction for reactor neutrons compared with that for γ rays is 1.0 ± 0.1 for Hole 51 and 1.4 ± 0.2 for Hole 19. This compares well with the value of 1.2 ± 0.1 determined from proton irradiations. The effect of forward scattering of neutrons was calculated for copper and zinc, and the average recoil energy from neutrons in the range 2 to 5 Mev was found to be roughly constant. This helps to explain the results from monoenergetic-neutron irradiations of germanium. (auth)

5490 (P-2012-ARPA) ELECTRICAL POWER FROM MAGNETOHYDRODYNAMIC (MHD) GENERATORS. J. H. Huth (RAND Corp., Santa Monica, Calif.). June 10, 1960. 13p. Contract AF49(638)-710.

Presented at the American Rocket Society Space Power Systems Conference held September 27-30, 1960, Santa Monica, Calif.

Principles of operation, general characteristics, applications, and development of magnetohydrodynamic electric generators are discussed. (C.J.G.)

5491 (PR-P-46) PHYSICS DIVISION PROGRESS REPORT [FOR] APRIL 1, 1960 TO JUNE 30, 1960. (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). 79p. AECL. (AECL-1109)

Progress is indicated on various projects in nuclear, general, neutron, and theoretical physics and electronics. Brief summaries containing some data are given. (For preceding period see PR-P-45.) (W.D.M.)

5492 (TID-6951) BASIC RADIATION STUDIES. Third Quarterly Progress Report for May 1960 – August 1960. (Johnston (William H.) Labs., Inc., Baltimore). 48p. Contract AT(11-1)-650. OTS.

Theoretical work consisted of the completion of studies on the bounded harmonic oscillator model in unimolecular reactions and the studies of the integrals that arose in connection with counting the energy states available to an assembly of loosely coupled harmonic oscillators. Photographic spectra of helium and nitrogen were obtained, but the resolution was unsatisfactory. Photographic spectra were taken of argon, nitrogen, and oxygen with greatly improved and satisfactory resolutions. These photographs are shown and a discussion presented of the changes leading to these satisfactory resolutions. Work is in progress on obtaining nonphotographic data by electronic counting. Multiple ionization phenomena are being investigated. (W.W.M.)

5493 (WAPD-DLE-323) PHOTOELASTIC ANALYSIS OF STRESS IN A THICK PERFORATED BAR IN SIMPLE TENSION. Research Report 100FF996-R10X. R. C. Sampson (Westinghouse Electric Corp. Research Labs., Pittsburgh). Feb. 10, 1960. 22p. Contract NObs 67500. OTS.

A photoelastic analysis of stress near the surfaces of a plate with multiple perforations subjected to uniaxial load was performed. (C.J.G.)

5494 (AEC-tr-4374) MEASUREMENTS WITH THE FIELD EMISSION MICROSCOPE OF THE SURFACE DIFFUSION COEFFICIENT AND PLACE EXCHANGE ENERGIES OF BARIUM ON TUNGSTEN SINGLE CRYSTALS. M. Drechsler. Translated by Robert Andelin and Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.) from Z. Elektrochem. 58, 340-5(1954). 17p. JCL.

A method was developed for measuring surface diffusion coefficients with the field emission microscope on single crystal surfaces. Measurements using barium on tungsten as an example show that surface diffusion coefficients on surfaces of a single crystal differ from each other by a factor of 10^4. Another method shows the measurement of surface specific place exchange energies of adsorbed foreign atoms on metals. The place exchange energies measured for barium on tungsten agree with theoretical values. (auth)

5495 (AEC-tr-4377) EFFECT OF HIGH PRESSURE ON SOME PHYSICAL PROPERTIES OF SOLIDS. K. P. Rodionov. Translated from Trudy Inst. Fiz. Metal., Akad. Nauk. S.S.S.R., Ural.' Filial No. 20, 273-82(1958). 16p. JCL or LC.

Theoretical and experimental investigations were made to determine the effects of high pressure on solids. The pressure effects on the physical properties of solids were determined by the behavior of ions in the crystalline lattice under pressure and by the behavior of the electron system under pressure. Laboratory research on the latter involved observations on the changes in electric and magnetic properties of some semiconductor compounds with rising pressure. It was found that pressure acting from all sides tends to delay phase transformation. Pressure on a lattice solid brings the participating atoms closer to one another; however, external pressure tends to eliminate imperfections such as distortions of the crystalline structure resulting from stresses which appear during cold plastic deformation under pressure. These two act in

opposite directions on the course of relaxation processes in a compressed crystal. Other theoretical and experimental findings are included. (J.R.D.)

5496 (NP-tr-532(Pts.I,II,&III) TABLES OF ELECTRON PHYSICS, ION PHYSICS, AND ELECTRON MICROSCOPY. VOLUME II. PARTS I, II, AND III. Manfred von Ardenne (Dresden. Technische Hochschule). (Translation). 4 in. thick. OTS.

5497 (SCL-T-351) THE REMOVAL OF ASTIGMATISM IN ROWLAND'S CONCAVE GRATING. (Über die Beseitigung des Astigmatismus beim Rowlandschen Konkavgitter). C. Runge and R. Mannkopff. Translated by Marcel I. Weinreich (Sandia Corp.) from Z. Physik 45, 13-29(1927). 19p. JCL.

The theory of Rowland's concave grating suggests the possibility of nullifying (canceling or off setting) the astigmatism of the image projection for any place in the spectrum by illuminating the slit with an astigmatic pencil or beam of rays. A number of combinations of mirrors and lenses that are capable of imparting astigmatism to the beam of rays are described whereby this astigmatism brings about a stigmatic image projection of the sources of light. Cylindrical lenses are superior to concave lenses, and it is preferable to use an arrangement consisting of a cylindrical lens and a spherical objective in cases of gratings having larger radii of curvature. (J.R.D.)

5498 SCATTERING OF ELECTRON BEAMS ON NEUTRAL ATOMS FOR VARIOUS THOMAS-FERMI POTENTIALS. T. Tietz (Univ. Lódź, Poland). Ann. Physik (7) 6, 262-6(1960). (In German)

Both exact and approximate expressions for the elastic differential scattering cross sections were derived for various Thomas-Fermi atomic potentials. The numerical results obtained for the elastic differential scattering cross sections were compared with the corresponding Hartree values. (tr-auth)

5499 SOME SOLUTIONS FOR STEADY LINEARISED MAGNETOHYDRODYNAMIC FLOWS. W. E. Williams (Univ. of Liverpool). Appl. Sci. Research 9A, 424-8(1960). (In English)

It is shown that the solution for the linearized magnetohydrodynamic equations of steady flow may be generated in terms of two independent scalar functions. The two cases of the unperturbed magnetic and velocity vectors parallel and perpendicular are considered. The analysis is applied to the case of steady flow past a wavy wall. (auth)

5500 ON SINGULAR SURFACES IN HYDROMAGNETICS. C. N. Kaul (Indian Inst. of Tech., Kharagpur, India). Appl. Sci. Research 9A, 437-49(1960). (In English)

By applying compatibility conditions of Thomas for surfaces of discontinuity in continuum mechanics, the singular surfaces of first and second order which may occur in the theory of hydromagnetics are discussed. It is shown that first-order singular surfaces are of two types; Alfvèn waves and contact type of discontinuities. The singular surfaces of second order turn out to be similar to singular surfaces of first order. An expression is obtained for the variation of the 'strength' of the Alfvèn wave as it propagates in a fluid at rest under constant pressure and magnetic field. It is shown that under certain conditions the strength of the Alfvèn wave as it propagates does not vary. (auth)

5501 SNAP 2. NUCLEAR SPACE POWER SYSTEM. J. R. Wetch, H. M. Dieckamp, and D. J. Cockeram (Atomics International, Canoga Park, Calif.). Astronautics 5, No. 12, 24-5(1960) Dec.

After a brief review of the history of the SNAP Project, the program objectives are set out and the SNAP-2 unit is described. The system consists of a 200-lb reactor, cooled by NaK, with a 1200°F outlet temperature and a hermetically sealed mercury-vapor power conversion system. The total weight is 600 lb and the output is 3 kw electrical for one year automatic. The reactor uses ZrH_4-U^{235} fuel reflected by beryllium and controlled by rotation of two semicylindrical beryllium drums. The core is a bundle of cylindrical fuel-moderator elements in steel tubes in a 9-in.-diam. core vessel. Coolant inlet temperature is 1000°F for the 50-kw thermal output. The power conversion system has a mercury-vapor two-stage axial-flow impulse turbine, an alternator, a centrifugal mercury pump, and a rotating magnet NaK pump all on one shaft, lubricated by mercury. Cycle rejection heat is radiated to space by a combined radiator-condenser which forms the outer part of the space vehicle. Shielding design and location of the unit as influenced by the space vehicle configuration are discussed, and data on dose rate versus distance are given. (T.R.H.)

5502 MEGAWATT ELECTRICAL POWER IN SPACE. D. P. Ross, E. Ray, E. G. Rapp, and J. E. Taylor (Thompson Ramo Wooldridge Inc., Cleveland). Astronautics 5, No. 12, 26-7; 72; 74; 76(1960) Dec.

The need for a megawatt-size electrical power plant for propulsion and auxiliary power for some space missions is pointed out, and reliability and weight criteria are examined. Materials requirements are discussed, and the performance of refractories and advantages of a potassium working fluid are discussed. The conceptual design offered incorporates a lithium-cooled fast reactor and a potassium vapor power system with four 250-kw sealed turbine-alternator condensate-pump units operating in an 800°F environment. Two basic heat-rejection systems are considered: one with condensation taking place in the radiator, and the other with condensation in a compact heat exchanger with rejected heat circulated to radiator by a liquid. (T.R.H.)

5503 A SPECIAL METHOD FOR THE PREPARATION OF DEFINITE RADIOACTIVE MEASUREMENT PREPARATIONS BY INTRODUCTION INTO PLASTIC FOILS. F. Thielemann (Institut für Radioaktivität, Leipzig). Atomkernenergie 5, 412-15(1960) Nov. (In German)

In a previous publication, the general principles of the incorporation of nuclides into plastics were treated. In this publication, a few specialized themes are discussed since the various isotopes behave differently during the process, according to their properties. Special attention is given to some of these nuclides, such as Tl^{204}, Po^{210}, and $Sr^{90} + Y^{90}$, since these isotopes are difficult to work on. The incorporation of such isotopes into plastics is accompanied by difficulties due to their relative high adsorption qualities, especially when exact activity statements are demanded. In addition to this, a report is made on a few specialized papers on the production of radioactive preparations. (auth)

5504 PRODUCTION OF RESONANCE RADIATION IN DISCHARGE TUBES OF NON-CIRCULAR CROSS-SECTION. M. A. Cayless (Associated Electrical Industries (Rugby) Ltd., Rugby, Eng.). Brit. J. Appl. Phys. 11, 492-8(1960) Nov.

The theory of d-c low-pressure metal-vapor rare-gas

discharges is developed, for the cases of simple one-stage and simple two-stage ionization, in a manner which enables the performance of a discharge in a tube of any given cross-sectional shape to be derived from that of an "equivalent" discharge in an "equivalent" tube of circular cross section. The latter can be obtained from a more detailed investigation of the discharge in a circular tube. It is shown that the discharges are capable of producing substantially more resonance radiation per unit length at a given efficiency in tubes of a "flattened" cross-sectional shape, than in tubes of a circular cross-sectional shape, particularly when there is a narrow, or waisted, middle section. Multi-stage ionization ultimately restricts the extent to which this improvement can be carried to aspect ratios of about 3:1. (auth)

5505 EFFECT OF SPIN DISORDER ON RESISTIVITY. P. G. de Gennes and J. Friedel. Colloq. nationaux centre natl. recherche sci. (Paris), p.287-94(1957). (In French)

The resistivity of magnetic metals was studied for the case where the spin carriers are bound to the atoms. The effect of short-range order was shown to be generally small even at the critical point. The inelasticity of the magnetic collisions between electrons and lattice could also be neglected, but this approximation became bad at low temperatures. In this region a spin-wave approximation was used. (auth)

5506 ON THE PROBLEM OF A SHOCK WAVE ARRIVING AT THE EDGE OF A GAS. Akira Sakurai (Massachusetts Inst. of Tech., Cambridge). Communs. Pure and Appl. Math. 13, 353-70(1960).

An investigation was made as to what kind of phenomena may be expected when a shock wave propagates through a nonuniform medium of decreasing density and reaches the boundary where the density vanishes. This situation may arise for shock waves moving in plasmas sustained by magnetic pressure. (T.R.H.)

5507 THE OPTIMUM PRESSURE FOR THE OPERATION OF HIGH FREQUENCY SOURCES GIVING POSITIVE ARGON IONS. ROLES OF THE EXTRACTION VOLTAGE, OSCILLATOR POWER, AND ITS FREQUENCY. Daniel Blanc and André Degeilh (Centre National de la Recherche Scientifique, Toulouse, France). Compt. rend. 251, 2009-11(1960) Nov. 7. (In French)

The intensity of the current extracted from a source with diaphragm was measured as an intensity of the pressure in the ionization chamber. The intensity is a maximum when the pressure is 21.5 μ of mercury, regardless of the values of the extraction voltage (from 3 to 6 kv), the oscillator power (up to 80 watts), and the frequency (from 100 to 200 MHz). (tr-auth)

5508 INTERACTION OF STRONG EXPLOSION WAVES WITH AN ELECTROMAGNETIC FIELD. V. P. Korobeinikov and V. P. Karlikov (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 133, 764-7(1960) Aug. 1. (In Russian)

A strong point-explosion in an infinitely conducting medium in a magnetic field is studied, and ionizing interactions of plane shock waves with a gas are analyzed. (R.V.J.)

5509 A METHOD OF SHOCK WAVE CALCULATION. V. F. Kuropatenko. Doklady Akad. Nauk S.S.S.R. 133, 771-2(1960) Aug. 1. (In Russian)

A method of calculation is suggested for the system $(\partial v/\partial t) = (\partial u/\partial x)$, $(\partial u/\partial t) = -(\partial P/\partial x)$, $(\partial E/\partial t) = -P(\partial v/\partial t)$, $P = f(E,v)$ (where u is velocity, P is pressure, v is specific gravity, E is inherent energy, and $f(E,v)$ is the arbitrary function). The method does not exhibit separate disruptions but can be considered a "through" method utilizing the Hugeniot conditions which hold only in disruptions. (auth)

5510 MAGNETIC RESONANCE. SOME APPLICATIONS IN THE AREA OF ATOMIC ENERGY. J. Combrisson (Commissariat à l'Énergie Atomique, Saclay, France). Énergie nucléaire 2, 290-4(1960) Sept.-Oct. (In French)

After a brief theoretical discussion of nuclear magnetism and electron magnetism, a number of applications of magnetic resonance peculiar to atomic energy are described with some details. Among the applications described are the measurement of magnetic fields, isotopic determinations, study of free radicals, color centers and faults in solids, and nuclear polarization. The examples should indicate that magnetic resonance can have a number of practical applications. (tr-auth)

5511 OSCILLOGRAPHIC METHOD STUDIES OF LUMINESCENCE DAMPING IN SOME POLYCRYSTALLINE PHOSPHORS. A. M. Sultanov and A. Kh. Khalilov. Izvest. Akad. Nauk Azerbaĭdzhan. S.S.R. Ser. Fiz.-Mat. i Tekh. Nauk No. 3, 31-7(1960). (In Russian)

The "partial time" method was used for determining the influence of silver, copper, and maganese activators and excitation light of various wavelengths on luminescence damping in ZnS, ZnS·CdS, and SiZn. The tests showed that with increased wavelength, the damping curves straighten out. Damping in the range $t > 0.0005$ sec does not follow an exponential low. An analysis of the results confirms the linear dependence of relaxation time (θ) on time t, $\theta(t) = (I)/(dI/dt) = (1/a\alpha) + (1/\alpha t)$, which is inherent to the hyperbolic (Becker) damping law with a fractional exponent. (R.V.J.)

5512 DIFFUSION OF Ag^+, Cl^-, AND Cd^{++} IN SILVER CHLORIDE SINGLE CRYSTALS. Richard F. Reade and Don S. Martin, Jr. (Ames Lab., Ames, Iowa). J. Appl. Phys. 31, 1965-8(1960) Nov. (IS-103)

The diffusion rates of silver, chlorine, and cadmium ions in single crystals of silver chloride were investigated by a modification of the surface counting method. The diffusion coefficient of the silver ion from 200 to 400°C was represented by the equation $D = 9.36 \exp(-1.01 \text{ ev/kT}) \text{ cm}^2/\text{sec}$. Estimates of chloride ion activation energies gave a value of 1.57 ev between 350 and 400°C, and a value of 0.37 ev below 280°C. The silver and chloride ion diffusion data were compared with results of workers who used sectioning methods. The diffusion coefficient of the cadmium ion may be expressed by the equation $D = 32.8 \exp(-1.36 \text{ ev/kT}) \text{ cm}^2/\text{sec} + 2.35 \times 10^{-5} \exp(-0.56/\text{kT}) \text{ cm}^2/\text{sec}$. (auth)

5513 ADIABATIC COLLAPSE OF A RELATIVISTIC ELECTRON BEAM. T. F. Godlove and D. C. DePackh (U. S. Naval Research Lab., Washington, D. C.). J. Appl. Phys. 31, 2016-24(1960) Nov.

Differential equations are derived and two computer solutions presented for the case of a relativistic electron beam injected into neutral gas. Processes included are ionization, scattering of electrons on atoms and ions, charge exchange, supply of neutrals to the beam by diffusion, and incoherent radiation by the electrons. A longitudinal electric field is assumed. The main restrictive assumptions are those of uniform densities and hydrodynamic stability. Solutions are given for an 1100-amp, 0.77-Mev, externally-focused beam injected into H_2 at pressures of 10^{-6} and 2×10^{-5} mm Hg. The beam contracts from an initial radius of 1.73 cm to an equilibrium radius of 7×10^{-4} cm in 3 and 0.5 msec, respectively. It is found in

these cases that neutrality of the beam does not occur until after the radiation-scattering equilibrium, which was first studied by Budker, has occurred. Several difficulties connected with a neutralized beam are discussed. It is shown that a space-charge-limited beam of high phase-space density is the type most suitable for obtaining a small beam diameter in the shortest time. An approximate solution is derived which applies after a specified time near equilibrium and allows calculation of several parameters of interest without the necessity of computer integration. (auth)

5514 CONSERVATION LAWS OF AN INTERACTING ELECTRON BEAM. Marshall C. Pease (Stanford Research Inst., Menlo Park, Calif.). J. Appl. Phys. 31, 2028-36(1960) Nov.

The linearized theory of electron beams interacting with a circuit is studied. Such systems may be considered as coupling the modes of, for example, the beam and the circuit. It was found, previously, that if these modes are properly defined, then there is a conservation law which states the constancy of the total power in these individual modes, independent of the extent of coupling. In single-frequency beam-type devices, this conservation law is Chu's kinetic power theorem. In multiple-frequency parametric systems, it is the linearized Manley-Rowe relation. The problem of such an interpretation is to determine what is an appropriate modal description that will lead to a convenient and useful conservation law. To obtain a systematic means of finding such a representation, it was observed that any linear homogeneous system with n degrees of freedom has n quadratic invariances. The kinetic power theorem and the linearized Manley-Rowe relation are examples of such quadratic invariances, which are distinguished from the others by being independent of certain of the parameters of the system. Methods are obtained for determining, from the differential equations of the system expressed in any appropriate variables, the quadratic invariance, if it exists, which is independent of a given parameter. If the basis is now changed to one which diagonalizes this invariance, then a modal, or wave, description is determined in terms of which the invariance becomes a kinetic power law, as it is usually written. This method of analysis is illustrated by application to the infinite-plane parallel beam, the interaction of a longitudinal thin beam with an incompletely coupled circuit, and the interaction of a weakly constrained filamentary beam with a transverse-field circuit. (auth)

5515 SECONDARY ELECTRON EMISSION OF MgO CRYSTALS BOMBARDED BY RELATIVISTIC ELECTRONS. Martin A. Pomerantz, Romas A. Shatas, and William C. Schieve (Bartol Research Foundation of the Franklin Inst., Swarthmore, Penna.). J. Appl. Phys. 31, 2036-9(1960) Nov.

The yield of single crystals of MgO was determined at a primary energy of 1.3 Mev, utilizing a modification of the "sandwich" technique developed earlier for investigating the secondary electron emission of metals at high primary energies. The value of δ for Al was measured concurrently under identical conditions. The accumulation of surface charges usually encountered with insulators is prevented by the bombardment-induced conductivity of MgO. The influence of multiple scattering and energy loss of the primary beam, as well as of δ-ray production, must be considered when the targets are relatively thick as in the present case. An empirical correction for normalizing the thick target measurements to thin target conditions was determined. The result is: $\delta_{MgO} = 0.09 \pm 0.02$ as compared with $\delta_{Al} = 0.023 \pm 0.003$. (auth)

5516 ON THE INCORPORATION OF NEODYMIUM IN MIXED YTTRIUM–NEODYMIUM–IRON GARNETS. G. Goldring, M. Schieber, and Z. Vager (Weizmann Inst. of Science, Rehovoth, Israel). J. Appl. Phys. 31, 2057-9(1960) Nov.

The preparation and saturation magnetization of yttrium–iron garnets containing various amounts of neodymium was investigated. The amount of neodymium which can be incorporated in the garnet structure was determined crystallographically and magnetically. The chemical analysis of the Nd/Y ratio was carried out by the counting of the characteristic x rays of neodymium produced by proton bombardment in a Van de Graaff accelerator. A compound with a formula of $YNd_2Fe_5O_{12}$ was found to be the richest iron garnet containing neodymium and has a saturation magnetization, at room temperature, of 4.25 ± 0.13 Bohr magnetons per formula weight compared to that of 3.55 ± 0.13 of $Y_3Fe_5O_{12}$ or $Sm_3Fe_5O_{12}$. (auth)

5517 EFFECT OF INTERELECTRODE SPACING ON CESIUM THERMIONIC CONVERTER PERFORMANCE. R. L. Hirsch (Atomics International, Canoga Park, Calif.). J. Appl. Phys. 31, 2064-5(1960) Nov.

In the cesium thermionic converter, energy dissipating interactions occur between emitted electrons and the "plasma," thus reducing the net electrical output. These interactions can be suppressed by reducing either the cesium pressure or the interelectrode distance. At very high emitter temperatures cesium primarily neutralizes space charges and its effects on the emitter work function are small. For operation at moderate temperatures (1400 to 2000°C), cesium may modify the emitter work function as well as reduce space charge. In this mode of operation, the cesium pressure is fixed, and departure from this optimum pressure results in drastic reductions in converter output. The interelectrode spacing then becomes a variable of great importance. The results of experiments conducted with a variable spacing converter at 1400 to 2000°C affirm the importance of spacing. These results are presented graphically for: spacing as a function of specific power at temperatures of 1650, 1700, 1750, and 1800°C; current as a function of voltage for interelectrode spacings of 3, 15, and 60 mils; and specific power as a function of voltage at spacings of 3, 15, and 60 mils. (B.O.G.)

5518 THE EFFECT OF PROTON GYRATION IN THE OUTER ATMOSPHERE REPRESENTED ON THE DISPERSION CURVE OF WHISTLER. Tadanori Ondoh (Kyoto Univ.) and Syoichiro Hashizume. J. Geomagnet. Geoelec. 12, 32-7(1960). (In English)

A short whistler observed at Kyoto was analyzed to detect the effect of proton gyration on the whistler dispersion. The parabolic distribution of electron density in the ionosphere was adopted. The propagation path of the whistler was divided into two parts with respect to altitude, and the electron density was constant in each part. Results indicated that the dispersion of whistlers observed at low geomagnetic latitude is clearly influenced by the effect of proton gyration in the outer atmosphere. (M.C.G.)

5519 MICROWAVE SPECTRUM OF IBr AND THE DETERMINATION OF THE MOLECULAR AND NUCLEAR PARAMETERS. Thadho S. Jaseja (Muslim Univ., Aligarh, India). J. Mol. Spectroscopy 5, 445-57(1960) Dec.

The microwave spectrum of IBr corresponding to the transitions $J = 4 \rightarrow 5$ and $J = 5 \rightarrow 6$ for the two isotopic species $I^{127}Br^{79}$ and $I^{127}Br^{81}$ was investigated. The spectrum obtained could be well explained on the basis of the theory given by Bardeen and Townes. The necessary secular equations were developed and solved and the frequencies of the lines corresponding to the expected transitions were calculated. The agreement between the calculated and the observed frequencies is satisfactory. The analysis of the spectrum yields the following molecular and nuclear parameters: $B_e(IBr^{79}) = 1682.22 \pm 0.1$ Mc/sec, $B_e(IBr^{81}) = 1656.51 \pm 0.1$ Mc/sec, $\alpha_e(IBr^{79}) = 10.49 \pm 0.1$ Mc/sec, $\alpha_e(IBr^{81}) = 10.26 \pm 0.1$ Mc/sec, $(eQq)_{Br^{79}} = 722 \pm 15$ Mc/sec, $(eQq)_{Br^{81}} = 603 \pm 15$ Mc/sec, and $(eQq)_{I^{127}} = 2731 \pm 60$ Mc/sec. The two different values of B_e for IBr^{79} and IBr^{81} yield a bond distance in IBr = 2.485 A. (auth)

5520 OPTICAL PROPERTIES OF KCl : Tl IN THE EXTREME ULTRAVIOLET REGION. Kiyoshi Aoyagi and Goro Kuwabara (Tokyo Univ.). J. Phys. Soc. Japan 15, 2334-42(1960) Dec. (In English)

The optical properties of KCl : Tl in the vacuum ultraviolet range were studied between room and liquid nitrogen temperatures. A new band was observed in both the absorption and excitation spectra on the long wavelength tail of the exciton band, i.e., 7.19 ev at −180°C. From the measurements of the temperature dependence and the emission spectrum, the band is supposed to be associated with a transition in chlorine ions in the neighborhood of a thallium ion. Excitation and emission spectra of fluorescence by the light in the fundamental band region, as well as thermal glow and optical stimulation curves of phosphorescence, were measured. The process of this luminescence is discussed. (auth)

5521 DETERMINATION OF THE ENERGY OF ANTIMONY-BERYLLIUM PHOTONEUTRONS. H. W. Schmitt (Oak Ridge National Lab., Tenn.). Nuclear Phys. 20, 220-6(1960) Oct. (4). (In English)

The transmission of a spherical shell of enriched B^{10} was measured and used to determine the average energy of neutrons from a spherical antimony-beryllium source. Analysis of the transmission data in terms of the known absorption and total cross sections of B^{10}, including effects of single and multiple neutron scattering in the shell and source, permitted determination of the effective energy of neutrons in the shell, the average energy of neutrons emitted from the particular source, and an estimate of the initial antimony-beryllium photoneutron energy. The average energy of neutrons from the neutron source was 24.0 ± 2.2 kev; the initial energy of the primary group of antimony-beryllium photoneutrons was 24.8 ± 2.4 kev. A discussion of the source neutron energy as a function of source dimensions is included. (auth)

5522 COMPETITIVE EXTINCTION IN NEUTRON MONOCHROMATING CRYSTALS. R. R. Spencer and J. R. Smith (Phillips Petroleum Co., Idaho Falls, Idaho). Nuclear Sci. and Eng. 8, 393-9(1960) Nov.

Large anomalies were observed in the Bragg beam produced by Be $(10\bar{1}1)$, Be $(10\bar{1}3)$, Be $(10\bar{1}0)$, and Be (0002) monochromators on the MTR crystal spectrometer. Instead of a smooth spectrum characteristic of a Maxwellian distribution of neutron velocities, many large dips were found. These dips appear to be caused by extinction of the beam due to Bragg reflection by planes in the crystal other than those supplying the Bragg beam to the spectrometer. Calculations of the angles at which such competition can be expected have resulted in the identification of the planes responsible for the principal dips. To establish that these anomalies are due to crystal properties, spectra produced by the (200), (220), and (240) planes of NaCl were examined. Although a few extinction dips were observed, these were far smaller in number and amplitude than those found in Be, caused by the simpler crystal structure and lower reflectivity of NaCl. These effects require careful consideration in high-accurace experiments with the crystal spectrometer, particularly in the measurement of reactor spectra. (auth)

5523 REACTIVITY COEFFICIENTS OF RARE EARTH OXIDES. J. Harry Mortenson and Russell M. Ball (Babcock and Wilcox Co., Lynchburg, Va.). Nuclear Sci. and Eng. 8, 448-9(1960) Nov.

Reactivity coefficients for some rare earth oxides are reported from measurements similar to those made in the Dresden Critical Assembly. The comparative data are tabulated. The accuracy of the average measurement is better than 0.1%, where most of the error results from period timing. The comparison of similar samples measured in the Dresden and the critical assembly for the NS Savannah show similar results; however, some differences are evidenced which may be attributable to the difference in neutron spectra of the two reactors. (B.O.G.)

5524 COMPARISON OF MEASUREMENTS WITH A MONTE CARLO CALCULATED SPATIAL DISTRIBUTION OF RESONANCE NEUTRON CAPTURE IN A URANIUM ROD. G. Smith, J. Hardy, Jr., and D. Klein (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng. 8, 449-51(1960) Nov.

A comparison is reported of measured and Monte Carlo calculated spatial distributions of U^{238} resonance neutron capture in a 0.387-in. diameter uranium metal rod in a hexagonal light-water moderated lattice with rod center-to-center spacing of 0.567 in. The following calculational results were obtained: (1) the fraction of neutrons started at 10 kev which are captured in the rod above 3 ev; (2) the fraction of total capture in each of the twenty rings across the rod; and (3) the fraction of total capture in each of 16 energy intervals for each of the two main regions of the rod. Curves are given which show the comparison of the adjusted Monte Carlo calculation with the measured spatial distribution. These results indicate that the code used is quite capable of giving a detailed prediction of the spatial distribution of resonance neutron capture across the rod diameter. It is significant to note that the agreement between experiment and calculation gives added justification to the treatment of the higher energy resonances. (B.O.G.)

5525 HYPERSENSITIZATION OF ILFORD NUCLEAR EMULSIONS BY TRIETHANOLAMINE. H. Faraggi and A. Garin (Centre d'Etudes Nucléaires, Saclay, France). Nuovo cimento (10) 17, 830-6(1960) Sept. 16. (In French).

It is possible to improve by a factor of the order of 1.7 the sensitivity of K-5 emulsions using appropriate treatment based on a pH 9.5 solution of triethanolamine and citric acid. (auth)

5526 ON THE CALCULATION OF THE VELOCITY OF SOUND IN GAS MIXTURES. V. S. Vrkljan. Nuovo cimento (10) 17, 845-9(1960) Sept. 16. (In German)

From relations between the velocities of sound, specific heats, and densities of gas mixtures of ideal gases and their components, a formula is developed for the velocity of sound propagation in gas mixtures of ideal gases. (D.L.C.)

5527 COMPARISON OF THE MEAN GAP LENGTH IN ILFORD G-5 EMULSION WITH THEORY. D. J. Holthuizen (Universiteit, Amsterdam). Nuovo cimento (10) 17, 928-37 (1960) Sept. 16. (In English)

Ionization measurements were made on the tracks of particles with velocities corresponding to β between 0.25 and 0.8. The results were obtained by the determination of the mean gap length. A theoretical curve is calculated with the help of the well-known relation between the relative grain density and the velocity as checked by Jongejans and the relation between the mean gap length and the grain density as given by Barkas. The results are in agreement with this theory. (auth)

5528 FURTHER DISCUSSION OF POSSIBLE EXPERIMENTAL TESTS FOR THE PARADOX OF EINSTEIN, PODOLSKY AND ROSEN. D. Bohm and Y. Aharonov (Univ. of Bristol, Eng.). Nuovo cimento (10) 17, 964-76(1960) Sept. 16. (In English)

In a previous article the experiment of Wu-Shaknov on the annihilation radiation of positronium was suggested as a test for the paradox of Einstein, Podolsky, and Rosen. In this article, certain criticisms of the conclusions raised by Peres and Singer are answered. These criticisms are shown to be erroneous, being based on an incorrect interpretation of the polarization of electromagnetic radiation in the quantum domain. (auth)

5529 RELATIVISTIC INCREASE IN BUBBLE DENSITY IN A $CBrF_3$ BUBBLE CHAMBER. B. Hahn and E. Hugentobler (Universität, Freiburg i. B.). Nuovo cimento (10) 17, 983-5(1960) Sept. 16. (In English)

Bubble density data are presented for high-energy pion and proton tracks in a 2-liter sensitivity stabilized bubble chamber filled with $CBrF_3$ exposed to a 16-Bev/c π^- beam of the CERN proton synchrotron. The particles produced in $K^0 \rightarrow \pi^+ + \pi^-$ and $\Lambda^0 \rightarrow p + \pi^-$ were identified, and the results are plotted vs. γ-1 for 14 K^0 decays and 4 Λ^0 decays. The plot shows a relativistic increase of density with energy as well as the expected decrease at low energies and fits the equation $\rho = 0.056/\beta^2\ [\log(\gamma^2-1) + 15 - \beta^2]$. (D.L.C.)

5530 SOUND VELOCITY, PHASE SEPARATION, AND LAMBDA TRANSITIONS OF He^3–He^4 MIXTURES. Thomas R. Roberts and Stephen G. Sydoriak (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids 3, 895-902(1960) Nov.-Dec.

The velocity of first sound was measured in saturated liquid He^3–He^4 mixtures ranging in composition from 20 to 90% He^3 between 0.5 and 2.3°K. The velocities decrease with increasing He^3 concentration due to the large increase in compressibility. The temperature T_λ at which a liquid mixture first begins to separate into two layers of different composition is identified by a break in the temperature derivative of the sound velocity. The values of T_λ are compared with and found to agree well with all other recent direct measurements. Breaks also occur in the temperature derivatives of first sound velocity and signal amplitude at temperatures which are in good agreement with most recent determinations of λ transition temperatures for concentrations up to 30%. For higher concentrations, the values obtained are in good agreement with λ points determined from second sound measurements but differ markedly from results based on the disappearance of boiling. Possible reasons for the differences are discussed. A smoothed table of λ temperature as a function of concentration is given up to the intersection of the λ line and the phase separation region at 68% He^3 and 0.86°K. The vapor pressure of pure He^4 at its λ point is 37.80 ± 0.01 mm Hg (at 0°C and standard gravity) based on the measured vapor pressure at the minimum sound signal and a calculated displacement of the sound minimum from the λ point. (auth)

5531 ION WAVE INSTABILITIES. Ira B. Bernstein and Russell M. Kulsrud (Princeton Univ., N. J.). Phys. Fluids 3, 937-45(1960) Nov.-Dec.

The dispersion relation for electrostatic oscillations in a magnetic field is derived on the basis of the Boltzmann equation for arbitrary velocity distributions and for propagation in an arbitrary direction under the following restrictions: (1) The thermal velocities of the particles and the phase velocity of the wave are small compared to those of light; (2) the component of the wave vector κ perpendicular to the magnetic field is small compared to the reciprocal of the gyration radius of an ion at the larger of the mean ion, and electron thermal, energies; (3) the magnetic field B is uniform. The dispersion relation is formally identical with that for electrostatic oscillations in the absence of a magnetic field. The dispersion relation is examined for stability under the further restrictions that: (4) The mean thermal energy of the ions is small compared to that of the electrons; (5) the electron distribution function for the component of the velocity v along B has a single maximum. It is found that a very small shift along B of this maximum relative to the ions leads to an unstable ion oscillation. The growth rates and frequencies of these oscillations are determined; their possible applications are discussed. Some further results on the "two stream" instability are given. (auth)

5532 IONIZATION GROWTH IN A GAS WITH A CONSTANT ELECTRIC FIELD. E. Gerjuoy and G. W. Stuart (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids 3, 1008-15(1960) Nov.-Dec. (GA-1433)

A model for the growth of ionization in a gas with a uniform electric field is studied by Laplace transform techniques. The total electron-molecule cross section is taken inversely proportional to the velocity; the ionization cross section may have arbitrary velocity dependence; all secondary electrons are created with zero energy; all collisions scatter electrons isotropically but produce no energy loss. With this model, in the steady-state spatially dependent case that primary electrons are continuously furnished by a cathode at z = 0, an exact solution is found for Townsend's α and for the asymptotic (valid at large z) electron distribution function integrated over velocity orientation. Similarly, in the spatially homogeneous time-dependent case that primary electrons are furnished at t = 0 by a uniformly distributed source, an exact solution is found for the time rate of ionization growth and for the asymptotic (valid at long times) electron distribution function integrated over velocity orientation. Numerical results, including effective electron temperatures are presented for several assumed ionization cross sections. Because of the neglect of energy loss, applicability of the model is limited to the high E/p (electric field/pressure) range. (auth)

5533 NONLINEAR BEHAVIOR OF THE ELECTRICAL CONDUCTIVITY OF A SLIGHTLY IONIZED GAS. Melvin Epstein (Univ. of Southern California, Los Angeles). Phys. Fluids 3, 1016-18(1960) Nov.-Dec.

Attention is directed to the nonlinear relationship between the current density and field strength of an applied oscillating electromagnetic field. It is pointed out that the general solution of this problem obtained by Margenau is too complex for use in further analyses except for the limiting case of vanishing field strength. A further approximation is introduced which yields a relatively simple expression for the current-field strength relationship, valid for large frequencies and moderate field strengths. It is found that

significant nonlinear effects may occur even at small field strengths if the gas density is sufficiently low. The effect of the nonlinearity is to increase that part of the current in phase with the applied field. (auth)

5534 ATTENUATION OF A MOVING MAGNETIC FIELD IN A SHOCK TUBE. V. Vali and T. E. Turner (Boeing Scientific Research Labs., Seattle). Phys. Fluids 3, 1029-31(1960) Nov.-Dec.

A description is given of measurements of the magnetic field associated with a circulating current traveling in an electrically driven shock tube. The history of the moving field was followed with pickup loops along the shock tube at 20-cm intervals. The present results, together with those of Scott and Wenzel, indicate that a traveling magnetic field is produced when a moving plasma interacts with the radial component of an externally imposed magnetic field. The observations suggest that the transport and diffusion effects be examined by considering the induction equation: $\delta H/\delta t = \nabla \times (v \times H) + \eta \nabla^2 H$, which reduces to the diffusion equation: $\delta H/\delta t = \eta \nabla^2 H$, in a moving coordinate system. From which the shock velocity is obtained $\eta \approx 4 \times 10^7$ cm^2/sec, compared to the solar photosphere $\eta \approx 10^8$ cm^2/sec. The transport effect is considered by defining the magnetic Reynolds number $R_m = [vH/L] + [\eta(H/L^2)] = vL\eta^{-1}$. For the present case, $R_m \approx 2$ which agrees well with the experimental observation that the moving field is nearly "frozen" in the gas. (B.O.G.)

5535 ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS. Gordon L. Cann (California Inst. of Tech., Pasadena). Phys. Fluids 3, 1031-2(1960) Nov.-Dec.

A study was made of the transport properties of species diffusion and thermal flux in a partially ionized gas in the presence of a magnetic field. Using the disciplines of irreversible thermodynamics and kinetic theory, equations were derived for electron and ion motion relative to the mass velocity of the gas. The equations apply over the ionization range $0 < n_i/n_a < 100$. Combining the equations in the form $|e|(n_i u_i - n_e u_e)$ the current density is obtained. In using the equations and applying boundary conditions valid at plasma-solid interfaces, it is possible to explain a number of puzzling phenomena that occur at arc electrodes without having to postulate new mechanisms. (B.O.G.)

5536 A METHOD FOR THE AUTOMATIC ESTIMATION OF GRAIN DENSITIES IN MICROAUTORADIOGRAPHY. P. P. Dendy (Univ. of Cambridge, Eng.). Phys. in Med. Biol. 5, 131-7(1960) Oct.

The method described for the estimation of grain densities in autoradiography uses a microscope with dark ground illumination. By means of a photoelectric cell the light scattered by the developed grains over a defined cell area is measured. An approximately linear relationship is found between photoelectric current and grain count. Tests of the method are described. (auth)

5537 EFFECT OF TARGET GAS TEMPERATURE ON THE SCATTERING CROSS SECTION. Arnold Russek (Univ. of Connecticut, Storrs). Phys. Rev. 120, 1536-42 (1960) Dec. 1.

If a beam of particles is scattered by a gas or plasma, the differential scattering cross section that is observed experimentally may, in some cases, be altered a discernible amount by the random thermal motion of the target particles. To explore the feasibility of using this effect as a means of measuring high temperatures, or to correct for the temperature of the target in the event that the desired cross section must be measured at high temperatures, a theoretical study was made of the temperature dependence of the cross section. A general expression was obtained for the observed differential scattering cross section in the laboratory frame in terms of the differential cross section in the center-of-mass frame for the general case of arbitrary initial motion of the target. Detailed results for the temperature dependence are given for hardsphere scattering (which is also applicable to low-energy neutron scattering) and for Coulomb scattering, in the approximation in which the projectiles are light and rapidly moving, compared to the targets. For hard-sphere scattering the case of equal projectile and target mass is also considered. (auth)

5538 RANGES OF 7.5- TO 52-kev H_2^+, D_2^+, He^+, AND Ne^+ IONS IN QUARTZ. R. L. Hines (Northwestern Univ., Evanston, Ill.). Phys. Rev. 120, 1626-30(1960) Dec. 1.

Experimental values of penetration depths of positive ions in quartz obtained from measurements of reflection coefficient vs. wavelength are compared with theoretical predictions. Measurements of the change in refractive index of quartz as a function of the energy dissipated per unit volume were found to give experimental values for the ratio of energy loss due to displacement collisions per unit thickness to the energy loss due to ionization per unit thickness. The energy loss due to displacement collisions per unit thickness agreed with theoretical predictions. From the experimental values of energy loss due to ionization, it was found that the cross sections for scattering of valence electrons by the field of the incident atoms are an order of magnitude larger than the geometric cross sections. (auth)

5539 DISPERSION RELATION FOR SPIN WAVES IN A fcc COBALT ALLOY. R. N. Sinclair and B. N. Brockhouse (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. 120, 1638-40(1960) Dec. 1.

Neutron spectrometry was used to measure the dispersion curve of the spin waves in a metal for the first time. The momentum distributions of inelastically scattered neutrons from a single crystal of fcc cobalt containing 8% iron were observed under constant energy transfer conditions. The observed neutron groups (which satisfied momentum and energy conservation between the neutrons and the spin-wave quanta) enabled the dispersion relation to be established. The response of the intensity of the neutron groups to an applied magnetic field was used to identify those of spin-wave origin. The dispersion relation was in agreement with the form predicted by the Bloch-Heisenberg spin-wave theory. Over the range of measurements, which was limited by the available spectrum of neutron energies, approximate isotropy was observed to hold. The value of the product of the exchange integral and the atomic spin was found to be $JS = (1.47 \pm 0.15) \times 10^{-2}$ ev. Assuming $S = 0.92$ the value for J was in poor agreement with a value obtained from the spin-wave interpretation of low-temperature magnetization data. Study of the widths of the neutron groups led to the conclusion that the mean lifetimes of some of the spin waves are greater than 3×10^{-13} sec. (auth)

5540 THEORY OF THE HYPERFINE ANOMALIES OF DEUTERIUM, TRITIUM, AND HELIUM-3$^+$. Daniel A. Greenberg and Henry M. Foley (Columbia Univ., New York). Phys. Rev. 120, 1684-97(1960) Dec. 1.

The covariant equation for the three-body deuterium system is discussed, and reduced to a three-dimensional equation for the case of instantaneous two-body interactions. A noncovariant perturbation scheme, based on this

three-dimensional equation, was employed to calculate the hyperfine structure to order $\alpha m/M$ (hfs) for $_1H^2$, $_1H^3$, and $_2He^{3+}$. The results are compared with the experimental values, and shown to be compatible. Final determination of the theoretical values and the adequacy of the theory is shown to depend critically on the determination of a number of experimental quantities, in particular on a more precise measurement of α, of the nucleon electric and magnetic form factors and associated nucleon polarization, of the presence and magnitude of a two-nucleon spin-orbit potential, and of the singlet n-p effective range. (auth)

5541 "REPULSION OF ENERGY LEVELS" IN COMPLEX ATOMIC SPECTRA. Norbert Rosenzweig (Argonne National Lab., Ill.) and Charles E. Porter. Phys. Rev. 120, 1698-1714(1960) Dec. 1.

It is shown that "repulsion of energy levels" of the same symmetry type occurs in complex atomic spectra. Thus, for the elements Hf, Ta, W, Re, Os, and Ir, for which the spin-dependent forces are relatively strong, the spacings between neighboring odd-parity levels of the same J value follow the Wigner distribution (approximately). For the elements Sc, Ti, V, Cr, Mn, Fe, Co, and Ni, for which the spin-dependent forces are relatively weak, a similar distribution is obtained for the odd-parity levels having fixed values for S, L, and J. (When the quantum numbers S and L are disregarded, the same levels give rise to a distribution of spacings which is approximated by a random superposition of a number of appropriately weighted Wigner distributions.) For the elements Y, Zr, Nb, Mo, Ru, Rh, and Pd, for which the spin-dependent forces are of intermediate strength, the empirical distribution of spacings between the odd levels of the same J value has a character which is intermediate between the Wigner and exponential distributions. All of these observations are explained in terms of a statistical model for the Hamiltonian matrix in the S, L, J, π representation. Quantitative results are obtained for a relatively simple form of the model which depends on only two parameters, viz., the dimensionality N and the ratio μ of the dispersions of the normal distributions for the off-diagonal and diagonal matrix elements. The transition from the exponential to the Wigner distribution occurs, roughly speaking, in the range of $N\mu^2$ from 0 to 1. The results of this work suggest that an empirical study of the distribution of the spacing between the energy levels of a complex quantum system may be capable of pointing to the existence of constants of the motion beyond those which are already known. (auth)

5542 BORN CROSS SECTIONS FOR INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. III. 5s, 5p, 5d, 5f, 5g STATES. S. N. Milford (Commonwealth Scientific and Industrial Research Organization, Sydney, Australia), John J. Morrissey, and Joseph H. Scanlon. Phys. Rev. 120, 1715-17(1960) Dec. 1.

Born total cross sections were computed for the strong optically allowed transitions from n = 5 to n' = 6, at incident energies between 0.2 and 1361 ev. Thirty energy values were considered for the 5s to 6p and 5g to 6h cases, and nine for the other transitions. The cross sections obtained were larger than those of comparable transitions for lower n. The Bethe (dipole) approximation was also used, and was found to give good agreement with the Born results down to relatively low energies (≈3 ev). (auth)

5543 ENERGY LOSS AND EFFECTIVE CHARGE OF HEAVY IONS IN ALUMINUM. L. C. Northcliffe (Yale Univ., New Haven). Phys. Rev. 120, 1744-57(1960) Dec. 1.

Heavy-ion beams of fixed initial energy ($E^0/m \approx 10$ Mev/amu) were passed through aluminum absorbers of known thickness, and the emergent ions were analyzed by means of a magnetic spectrograph to determine their charge and energy distributions. Accurate measurements of the mean emergent ion energy as a function of absorber thickness are reported for beams of He^4, B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, F^{19}, and Ne^{20} ions with emergent energies in the range $10 > E/m > 1$ Mev/amu. The results can be interpreted as measurements of the range-energy relation for heavy ions. While the absolute accuracy of the range measurements is approximately ±1 mg/cm^2, the range difference $R(E^0)-R(E)$ is measured (as a function of E) with a typical accuracy of ±0.1 mg/cm^2. In the analysis the shape of the heavy-ion range-energy curve was compared with the accurately known shape of the proton range-energy curve (using the conversion factor $\Delta R = mZ_p^2(m_p Z^2)^{-1}\Delta R_p$) and the differences in shape were attributed to deviations of the effective charge of the ion from its nuclear charge. No detectable difference was found between the shape of the range-energy curve for He^4 ions and for protons. For heavier ions, deviations in the curve shape did occur. A simple empirical formula was found for the effective charge of an ion as a function of its velocity which was consistent with the deviations of the observed range-energy curves and presumably can be used to predict the range-energy curves for ions not investigated experimentally. By an independent analysis of the spectrograph data the equilibrium distribution of charge states in the O^{16} beam was determined as a function of emergent beam energy. The effective charge implied by the charge state distribution was found to be consistent with the effective charge as given by the empirical formula. (auth)

5544 ENERGY LOSS MEASUREMENTS FOR HEAVY IONS IN MYLAR AND POLYETHYLENE. Philip E. Schambra, Andrew M. Rauth, and L. C. Northcliffe (Yale Univ., New Haven). Phys. Rev. 120, 1758-61(1960) Dec. 1.

The energy loss of C^{12}, O^{16}, and Ne^{20} ions in passage through foils of Mylar and polyethylene was investigated for incident ion energies of 10 Mev/amu and emergent ion energies in the region from 10 to 1 Mev/amu. The ion energies were measured with a magnetic spectrograph. The variation of emergent ion energy with absorber thickness (essentially the range-energy relation) is reported and compared with similar results for the same ions in aluminum. Within experimental error, the curves for Mylar and polyethylene differ from those for aluminum only in the scale of absorber thickness. For the same energy loss, the ratio of absorber thicknesses (in mg/cm^2) is 0.783 for Mylar to aluminum, and 0.692 for polyethylene to aluminum. (auth)

5545 NUCLEAR ORIENTATION OF IODINE BY ELECTRIC hfs ALIGNMENT. C. E. Johnson, J. F. Schooley, and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev. 120, 1777-80(1960) Dec. 1. (UCRL-9216).

Nuclear alignment of iodine in a single crystal of copper p-iodobenzenesulfonate at a temperature of about 0.03°K was detected by measurement of the anisotropic angular distribution of γ radiation from aligned I^{131}. No evidence was found for a nuclear spin-lattice relaxation time longer than a few seconds. The spin of the 637-kev level in Xe^{131} was established as 5/2, and the E2/M1 mixing ratio of the 364-kev transition was found to be $\delta = -6.7 \pm 0.5$. The quadrupole coupling constant eQq/h was found to be -950 ± 190 Mc/sec. (auth)

5546 ON THE QUANTIZATION OF PHYSICAL SPACE-TIME OPERATORS. Ichie Watanabe (Tokyo

Univ.). Progr. Theoret. Phys. (Kyoto) 24, 465-83(1960) Sept. (In English)

In order to find a clue to extending the conventional field theory in a consistent way, a physical interpretation of Dirac-Bergmann's field theory is proposed from the point of view of the uncertainty principle. The physical space-time operators introduced by them are connected with the measurement of the position. Further a new formulation of the auxiliary condition, which is the direct consequence of the quantization of the physical space-time operators, is constructed and then the consistency and the detailed structure of the formalism are made clear. (auth)

5547 THEORY OF CLASSICAL FLUIDS AND THE CONVOLUTION APPROXIMATION (NOTE ON PAPERS BY TOHRU MORITA). Emmanuel Meeron (Boeing Scientific Research Labs., Seattle). Progr. Theoret. Phys. (Kyoto) 24, 588-92(1960) Sept. (In English)

A method employed by Morita for the approximate calculation of free energy and pair distribution function of classical fluids is seen to be identical with the nodal expansion method. The limit of the nodal expansion sequence results in an approximate integral equation for the potential of average force. This convolution approximation is seen to be consistent with the Ornstein-Zernike theory of fluids, and thus provides a convenient means for investigating the behavior of fluids near the critical point. The convolution approximation results also from neglecting the nonconvolutory terms in an exact integral equation for the pair distribution function. (auth)

5548 VIBRATIONAL THERMODYNAMIC PROPERTIES OF LATTICES WITH DEFECTS. II. TWO- AND THREE-DIMENSIONAL SIMPLE CUBIC LATTICES. J. Mahanty, A. A. Maradudin, and G. H. Weiss (Univ. of Maryland, College Park). Progr. Theoret. Phys. (Kyoto) 24, 648-60(1960) Sept. (In English)

A continuation is given of the application of methods to two- and three-dimensional crystals for the evaluation of the changes in thermodynamic properties of a lattice caused by the presence of various defects. Considerations are given for the effects of an isotope defect and a pair of isotope defects on the zero point energy and free energy of two- and three-dimensional cubic lattices. The free energy and self entropy of a vacancy are evaluated in a three-dimensional cubic lattice. (auth)

5549 MATRIX ELEMENTS FOR THE ENERGY OPERATOR OF d-ELECTRON SPIN-ORBIT INTERACTIONS. S. A. Zvironaĭte (Zhvironaĭte) and R. S. Dagys (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Vil'nyus State Univ., [Lithuanian SSR]). Trudy Akad. Nauk Litovskoĭ S.S.R., Ser. B No. 3, 3-13 (1960). (In Russian)

Expressions are developed for sub-matrix elements of the spin-orbit interaction energy operator for d^5 configurations and for interactions of nonsaturated d shells with saturated s and p shells. (tr-auth)

5550 HYPERFINE STRUCTURE OF Eu-II. K. Krebs and R. Winkler (Technische Universität, Berlin). Z. Physik 160, 320-32(1960) Oct. (In German)

By means of a Fabry-Pérot interferometer the hyperfine structure of 10 lines of the Eu-II spectrum was analyzed, and from the results splitting factors and isotope shifts were calculated. When evaluating the magnetic moment μ of Eu it was found that the two ground states ($a^9S_4^0$ and a $^7S_3^0$) of Eu-II yield two distinctly different values for μ. This discrepancy can be removed by assuming that a different electronic splitting factor (a_{6_s}) has to be attributed to the 6s-electron in each of these two states. (auth)

5551 1960 NUCLEAR DATA TABLES. PART 3. NUCLEAR REACTION GRAPHS. J. B. Marion (National Research Council. Nuclear Data Group). Aug. 1960.

A collection of 69 graphs and various tables is presented which exhibit range-energy relations, cross sections for neutron production, crystal efficiencies, conversion factors, calibration energies, and other data frequently needed in nuclear reaction studies. (W.D.M.)

5552 EFFECT OF ELECTRODE REFRACTION ON ION BEAM COLLIMATION AND NEUTRALIZATION. G. C. Baldwin (General Electric Co., Schenectady, N. Y.). Paper No. 1158-60. Presented at the ARS Semi-Annual Meeting, Los Angeles, California, May 9-12, 1960. New York, American Rocket Society, 1960. 11p.

Efficient electrode structures for acceleration of ions in electrical propulsion systems are commonly designed to establish a potential function at the beam edge identical with that characteristic of space charge limited flow. Since the accelerated beam is intended ultimately to generate thrust, it must emerge from an aperture in the accelerator with a good degree of collimation. Consideration must therefore be given also to refraction by the transverse fields unavoidably associated with electrode apertures. In general, an aperture separating a region in which ions undergo acceleration from a region of lower or negative acceleration acts as a divergent lens; if the final stage is decelerating, the exit aperture acts as a convergent lens of greater strength than the aperture preceding it. It can be shown that plane parallel flow in the acceleration region is incompatible with full collimation of the ejected ion beam. The radius of curvature of the beam as it enters the final electrode aperture, the degree of final beam collimation, and the current density which can flow at a given exit voltage are therefore interrelated. This forces a compromise between degree of collimation and perveance and determines the maximum thrust attainable at a given specific impulse from an emitter of given radius. These considerations apply not only to single stage ion guns but also to multi-stage (including "accelerate-decelerate") systems. Several recent descriptions of multi-stage Pierce Gun systems appear to ignore this problem. Application to the design of a particular accelerate-decelerate electrode configuration is described. (auth)

5553 ION EROSION OF ACCELERATING ELECTRODES IN SPACE VEHICLES. J. S. Luce (Oak Ridge National Lab., Tenn.). Paper No. 1159-60. Presented at American Rocket Society Semi-Annual Meeting, Los Angeles, Calif., May 9-12, 1960. New York, American Rocket Society, 1960. 18p.

The wear rate of accelerating electrodes due to ions striking them was investigated. The number of primary ions striking the slit was found to be very small. Ionization of neutral gas near the accelerating electrodes was a much greater source of sputtering than that produced by scattering of the primary ion beam. Essentially all ions created in the accelerating gap were found to strike the accelerating slit. Results indicated that the use of an accelerating-decelerating system increased erosion of the slits. A tabulation of wear on various grids is included. Some wear was caused by improper optics in the arc sheath. The wear rate was greatest in the regions where focusing was poorest. Some losses appeared to be due to sparking and evaporation. A tabulation of the propulsion characteristics of deuterium and argon is also included. (M.C.G.)

5554 DESIGN AND PERFORMANCE OF SMALL MODEL ION ENGINES. G. R. Brewer, J. E. Etter, and J. R. Anderson (Hughes Research Labs., Malibu, Calif.). Preprint. Presented at the American Rocket Society Meeting, Los Angeles, Calif., May 9-12, 1960. New York, American Rocket Society, 1960. 13p.

Results of fundamental studies on ion engines with emphasis on those characteristics which are strongly dependent on the optical properties of the ion accelerator are given. An accurate knowledge of electron and ion trajectories was found to be essential to proper design of the ion accelerator and neutralizer regions. Except for charge exchange ions, the accelerator interception in a properly designed gun was largely a result of particles emitted with transverse thermal velocities and could be made as low as 10^{-4}. Effective charge neutralization of the ejected ion beam was obtained. (M.C.G.)

5555 SPACE CHARGE MEASUREMENTS IN EXPANDING ION BEAMS. J. M. Sellen and H. Shelton (Ramo-Wooldridge, Canoga Park, Calif.). Paper No. 1160-60. Presented at the ARS Semi-Annual Meeting and Astronautical Exposition, Los Angeles, California, May 9-12, 1960. New York, American Rocket Society, 1960. 42p.

The influence of space charge fields in the dynamics of beams of charged particles was examined to determine the possibility of the production of thrust by electrical means. A simple model of an expanding ion beam was set up and the profiles of the expanding beam, the axial field, and the potential along the axis of the beam were calculated. A process by which the space charge effects of the ions are counteracted by electrons trapped in the beam was observed. Under the conditions of the experiment, the times required for this build-up of trapped negative charge to effectively counteract the ionic space charge were shown to be of the order of several milliseconds. Results indicated that moderate aspect ratio beams will not be seriously affected by space charge forces. (M.C.G.)

5556 NEUTRALIZATION EXPERIMENTS ON BROAD CESIUM ION BEAMS. J. M. Sellen and H. Shelton (Ramo-Wooldridge, Canoga Park, Calif.). Paper No. 1161-60. Presented at the ARS Semi-Annual Meeting and Astronautical Exposition, Los Angeles, California, May 9-12, 1960. New York, American Rocket Society, 1960. 12p.

Experimental results related to space-charge neutralization are reported. A 1-in. dia. porous tungsten cesium source with an accelerating spacing of about 1 mm was used to produce approximately one-dimensional ion flow. This led to the stalling of ions and the production of a planar virtual source approximately one acceleration distance in front of the accelerator. It was also found that under some conditions the beam could be caused to proceed without stalling to the collector, even if the collector was hundreds of acceleration distances away. It was concluded that in these instances electrons traverse the initially stalled ion beam causing ionization or excitation of the neutral gas. To test this interpretation a pulsed experiment was performed to gain insight into the trapping mechanism. The length of time it took the trap to fill, as indicated by the collection of ion current at large distances, was measured and correlated with gas pressure, electron current, spacings and other variables. The trapping rate was found to be cumulative and depend on the number of trapped electrons which retain enough energy to cause ionization. (M.C.G.)

5557 RECENT DEVELOPMENTS AND DESIGNS OF THE ION ROCKET ENGINE. Robert H. Boden (North American Aviation, Inc., Canoga Park, Calif.). p.463-82 of "Proceedings [of the] Xth International Astronautical Congress, London, 1959." Vienna, Springer-Verlag, 1960. (In English)

A summary is presented of the basic relations governing the operation of electrical propulsion systems in order to explain the trend of the progress achieved in the development of ion rocket engines. Fundamental design parameters of the engines are tabulated. Considerations for estimating the cross-sectional area of engine design are described. The relation of engine design, vehicle design, and mission results from the characteristic velocity required to accomplish the objective. The mission analysis methods result in characteristic velocity requirements that establish the specific impulse or exhaust velocity the engine must develop. Examples are given to demonstrate the variation of payload with specific impulse. The analytical relation among the characteristic velocity, weight per unit power of the vehicle, efficiency, and the specific impulse to obtain maximum payload is graphically represented. The maximum payload for a mission accomplished with an electrically powered vehicle is estimated. Since the operating time of the vehicle is partly dependent on the thrust-to weight ratio, the limiting ratios were graphically summarized for several types of vehicles including ion, plasma, and chemical rockets and modern aircraft. The experimental program and techniques for verifying these analyses on a specific type of ion rocket engine that uses electrostatic acceleration of ions generated from surface contact ion sources are presented. A preliminary evaluation of the experimental results is discussed. (B.O.G.)

Astrophysics and Cosmology

5558 (EFINS-60-58) THEORIES ON THE ORIGIN OF METEORITES. Edward Anders and Gordon G. Goles (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies). Nov. 1960. 43p. Contract AT(11-1)-382. OTS.

Three principal theories of the origin of meteorites, differing chiefly in dimensions proposed for the parent bodies, are analyzed. The theories postulate the parent bodies to have been of: (1) planetary size; (2) two successive generations, one of lunar size and one of asteroidal size; and (3) asteroidal size only. Evidence supporting each theory is presented. (C.J.G.)

5559 SYNTHESIS OF IRON GROUP ELEMENTS BY THE RAPID NUCLEAR PROCESS. Minoru Nishida, Hiroshi Tsuda, and Hiroyuki Tsuji (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 685-7(1960) Sept. (In English)

An investigation was made of whether the cosmic abundances of the elements in the iron peak can be explained in terms of the rapid nuclear process supposed to take place during the initial phases of supernova explosions. From calculations of rates reaction induced by protons, α particles, and their antiparticles, it is seen that the formation of elements, beginning with Ca^{40}, is determined by (p,γ) and (γ,p) reactions and β^+-decays which are faster than the characteristic time scale of nuclear synthesis duration in the exploding envelope of a supernova, 10^2 to 10^3 sec. The abundances of nuclei were calculated assuming that a steady state is reached in which the abundance of each nuclide is proportional to its proton-capturing or β^+ decay time. The final abundances of stable isotopes were determined by considering only β^+ decays as the freezing reaction in the envelope cooling stage. Considering the uncertainty of nuclear masses of proton-rich nuclides, it is

concluded that the abundances of the iron peak elements can be explained in terms of the rapid process. (B.O.G.)

Cosmic Radiation

5560 (CRGP-965) MAGNETIC CUT-OFF RIGIDITIES ACCORDING TO THE FORMULATIONS OF P. ROTHWELL, AND OF J. J. QUENBY, AND W. R. WEBBER. L. L. Cogger (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Sept. 1960. 13p. (AECL-1104). AECL.

Vertical cut-off rigidities were calculated with the Chalk River computer for all cosmic-ray stations over the world according to Rothwell's and Quenby and Webber's equations, modifying the assumption of the earth's field as a dipole to fit the Admiralty charts of local magnetic fields. The derivation of these equations is given. (D.L.C.)

5561 COSMIC RAY SHOWERS. Kenneth Greisen (Cornell Univ., Ithaca, N. Y.). Ann. Rev. Nuclear Sci. 10, 63-108(1960).

A survey is given of literature pertaining to investigations of cosmic showers. The discussions are related to the significance of extensive air showers; methods for the observation, identification, and energy measurement of particle components in showers; and problems confronting research on extensive air showers and areas in which progress is forthcoming. The survey concerns the analysis of cosmic showers, which is carried on, not only to reveal the behavior of high-energy particles, but also in the reasonable expectation that the radiation contains extractable information about its source and about the space through which it has propagated. (B.O.G.)

5562 EXPERIMENTS ON COSMIC RAYS AND RELATED SUBJECTS DURING THE INTERNATIONAL GEOPHYSICAL YEAR. E. P. Ney (Univ. of Minnesota, Minneapolis). Ann Rev. Nuclear Sci. 10, 461-88(1960).

A survey is given of literature pertaining to experiments conducted on cosmic rays and related subjects during the IGY. Experiments show that a solar cycle dependence of cosmic-ray intensity exists and demonstrate that several days following strong solar disturbances, cosmic rays suffered abrupt decreases, now called Forbush decreases, recovering to their predecrease intensity in a matter of weeks. Not only have the natural phenomena existing in the vicinity of the earth been studied, but the understanding of these phenomena led to a series of experiments in which energetic nuclear particles were injected into the magnetic field of the earth and this man-made radiation shell was studied with earth-circling satellites. 45 references. (B.O.G.)

5563 THE COSMIC RAY EQUATOR AND THE GEOMAGNETISM. Kunitomo Sakurai (Kyoto Univ.). J. Geomagnet. Geoelec. 12, 13-20(1960). (In English)

It was formerly thought that the disagreement of the position of geomagnetic dipole equator with that of the cosmic ray equator was caused by 45° westward shifting of the latter. Referring to the theory of geomagnetic effect on cosmic rays, it was determined whether such westward shifting could be existent or not. It was found that the deviation of the cosmic ray equator from the geomagnetic dipole equator is negligible even if the magnetic cavity is present around the earth's outer atmosphere. Taking into account such results, the origin of the cosmic ray equator was investigated. It was found that this equator could be produced by the higher harmonic components combined with the dipole component of geomagnetism. The relation of the origin of the cosmic ray equator to the eccentric dipoles, near the outer part of the earth's core, contributing to the secular variation of geomagnetism was considered. (auth)

5564 AN INVESTIGATION OF THE FORBUSH DECREASES IN THE COSMIC RADIATION. John A. Lockwood (Univ. of New Hampshire, Durham). J. Geophys. Research 65, 3859-80(1960) Dec.

An analysis was made of the large and rapid Forbush decreases in the cosmic radiation that occurred from 1954 to 1959. Data from the IGY network of cosmic-ray stations were utilized to determine the changes in the primary rigidity spectrum, of any significant differences in the onset times, and the existence of anisotropies during the decreases. To evaluate changes in the primary spectrum during a decrease, it is necessary to know the spectrum before the event. It was found that this long-term variation is adequately described by a modulation of the primary spectrum given by $1 - C(t)P^{-1}$, where $1 \leq C(t) \leq 2.5$ and $C(t)$ is a function of time in the solar activity cycle. For individual decreases the modulation is $1 - \{C(t_F)P^{-1} + k_F\}$, where $0 \leq k_F \leq 4\%$ for nucleonic detectors at sea level and mountain elevations and $0.6 \leq C(t_F) \leq 2.2$. No systematic variations of the onset times were evident, except for the smaller decreases where the effect of any superimposed daily variation is important. The primary radiation remained isotropic during the large decreases. These events were preceded within 3 hr by a sudden commencement geomagnetic storm. These results are discussed in terms of possible solar-modulating mechanisms. (auth)

5565 THE COSMIC RAY ALPHA-PARTICLE FLUX DURING SHARP FORBUSH INTENSITY DECREASES. Peter Meyer (Univ. of Chicago). J. Geophys. Research 65, 3881-7(1960) Dec.

During three large Forbush-type intensity decreases that occurred on May 12, July 15, and July 18, 1959 the primary cosmic-ray α-particle flux was measured at balloon altitudes. A comparison with the α-particle flux in an undisturbed period on Sept. 28, 1959, and with the total cosmic-ray intensity as observed by neutron monitor stations showed a close correlation between the α-particle flux and the total cosmic-ray flux during Forbush decreases. This evidence clearly established the fact that the proton and α-particle components are modulated by a common mechanism during the sharp intensity decreases. The measurement of May 16, 1959, exhibited an increase in the α-particle flux by 30% within approximately 9 hr which was not accompanied by a comparable variation in the proton flux. Similar, independent changes in the α-particle flux earlier were noted to follow Forbush decreases. During quiet days the primary α-particle flux with energies exceeding 560 Mev/nucleon was about 20% higher in 1959 than in 1958. This change in intensity is probably related to the beginning decline in average solar activity. (auth)

5566 THE SOLAR COSMIC-RAY OUTBURST OF MAY 4, 1960. J. C. Anderson, R. L. Chasson, M. P. Liwschitz, and T. Suda (Univ. of Nebraska, Lincoln). J. Geophys. Research 65, 3889-94(1960) Dec.

Low-energy nucleonic cosmic-ray data from stations at Lincoln, Mt. Washington, Sulfur Mountain, and Deep River were studied with regard to onset times, time and magnitude of maximum increase, and decay characteristics. The decay behavior underwent a definite transition that is clearly related to the termination of the optical flare. The first part of the decay was exponential, with a time con-

stant in the neighborhood of 17 min, whereas the latter part was not distinctly established either as exponential (with a possible time constant of 78 min) or as following a $t^{-1.5}$ law. Ordinary impact zones did not seem to fit the pattern of increases observed at various stations in the northern hemisphere. (auth)

5567 SOLAR FLARE COSMIC-RAY INCREASE OF MAY 4, 1960. R. B. Brode (Univ. of California, Berkeley), R. R. Brown, and W. R. Steiger. J. Geophys. Research 65, 4200-1(1960) Dec.

Observations of cosmic-ray intensity obtained with neutron monitors during the period 1000 to 1200 UT of May 4, 1960, are presented. This increase was caused by a solar flare of importance 2 in a region near the west limb of the sun. The intensity variations are compared with those associated with the event of February 23, 1956. (M.C.G.)

5568 SHORT-PERIOD TIME VARIATIONS OF EXTENSIVE COSMIC RAY SHOWERS. Donald G. Yerg and Phyllis M. Gildersleeve (Michigan Coll. of Mining and Tech., Houghton). Nature 188, 651-2(1960) Nov. 19.

An experiment was conducted to determine whether or not short-period fluctuations in the arrival of extensive showers are sufficiently systematic to warrant detailed study. An oscillograph recording was made of the output of two G-M tubes. Twelve spectral estimates were obtained for each curve. The results indicated that long time intervals between successive counts tended to be followed by long intervals approximately 4 to 9 counts later. Since the average time interval between counts was 74 sec, a systematic variation of 5 to 11 min in the arrival of extensive air showers was indicated. (M.C.G.)

5569 A METHOD FOR DETECTING THE POSSIBLE EXISTENCE OF HIGH ENERGY DEUTERONS IN THE PRIMARY COSMIC RADIATION. R. R. Daniel (Tata Inst. of Fundamental Research, Bombay), P. J. Lavakare, and P. K. Aditya. Nuovo cimento (10) 17, 837-44(1960) Sept. 16. (In English)

A method that can be used for detecting the presence of high-energy deuterons in the primary cosmic radiation is described. The suggested method takes advantage of the fact that when only the neutron of the incoming deuteron takes part in a collision and gives rise to a star in a nuclear emulsion, the proton continues in the forward direction almost undeviated. Such stars, referred to as (d,p) stars, can provide evidence that the incoming particle is a deuteron. In order to use this method it is necessary to know (i) the interaction mean free path λ_d of high-energy deuterons in nuclear emulsions; and (ii) the proportion f(d,p) of deuteron-induced interactions in which only the neutron takes part. These were determined to be λ_d = 15.8 cm and f(d,p) = 0.4. The suggested method is applicable if deuterons constitute $\gtrsim$5% of the singly charged particles in the primary radiation. (auth)

5570 INVESTIGATION OF AN ELECTRON-PHOTON CASCADE OF MORE THAN 10^{13} EV. D. M. Haskin, E. Lohrmann, M. W. Teucher, and M. Schein (Univ. of Chicago). Nuovo cimento (10) 17, 986-8(1960) Sept. 16. (In English)

A very dense cascade shower was found in a 200-sheet stack of 60 × 30-cm nuclear emulsions exposed in Texas above 110,000 ft and is ascribed to a single γ ray or two γ rays from the same π^0 meson. This cascade, very near to the shower axis and before the cascade maximum, is treated as a pure electron-photon cascade and is analyzed by target diagrams made at varying distances from the shower origin. The distribution of the high-energy electrons in the cascade agrees with the predictions of cascade theory, the primary energy being 2.3×10^{13} ev for the best fit. (D.L.C.)

Criticality Studies

5571 (LAMS-2455(p.195-8)) NEUTRON FLUX, SPECTRA, AND NEUTRON AND GAMMA TISSUE DOSE EVALUATIONS AT THE LITTLE EVA CRITICAL ASSEMBLY. J. A. Sayeg, D. G. Ott, and P. S. Harris (Los Alamos Scientific Lab., N. Mex.).

Due to the demand for critical assembly time, it was necessary to calibrate existing critical assemblies that could be used for radiation effects tests. Data are presented on the radiation characteristics of the Los Alamos Little Eva critical assembly. (C.H.)

5572 WATER-MODERATED CORES WITH BORON STEEL SEPTA AT ELEVATED TEMPERATURES. G. D. Hickman, J. A. Bistline, and L. A. MacNaughton (Knolls Atomic Power Lab., Schenectady, N. Y.). Nuclear Sci. and Eng. 8, 381-92(1960) Nov.

A series of 15 experiments was carried out on an 8 × 30 × 32 in. core in the Pressurized Critical Assembly at KAPL. In 12 of these experiments, 0.030-in. boron stainless steel septa bisected the 8-in. dimension. These septa contained various weight per cent B^{10}. In the remaining three experiments, there were no boron-stainless steel septa in the core. The eigenvalues and neutron density distributions were compared with values calculated from Deutsch cross sections and "Thin Region Theory." The calculated eigenvalues were within 1% of the experimental values, with a spread of approximately 1%. For all the cores, the calculated eigenvalues were lower than the experimental values. Analyses of the neutron density distributions showed the calculated results in fairly good agreement with the experimental results. In all cases, this agreement was as good for the cores which contained the boron septa as for the ones which did not. It therefore appears that the boron was well represented by "Thin Region Theory," and that the main discrepancies between calculated and experimental values are due to the inadequacies of adapting the Deutsch scheme to these cores. (auth)

Elementary Particles and Radiations

5573 (AAEC/E-54) SPECTRUM CALCULATIONS FOR NEUTRONS SLOWING DOWN BY ELASTIC COLLISIONS. J. P. Pollard (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nov. 1960. 18p.

A method is suggested for obtaining the collision density as a function of lethargy for neutrons slowing down in an infinite homogeneous moderator containing uniformly distributed sources of fission neutrons. The reactions considered include elastic scattering, spherically symmetric in the center of mass system, and absorption. The solution, which is exact for single element moderators when the only neutron reaction is elastic scattering, extends the well known Greuling–Goertzel approximation and shows that it is in error by no more than 13%. The method is also exact for a mixture of nuclides, provided the cross section ratios are energy independent, and is a useful approximation otherwise. (auth)

5574 (AFCRL-TN-60-1153) COLLISION CROSS SECTIONS THEORY AND PRACTICE, FORMAL THEORY FOR DISTINGUISHABLE SPINLESS PARTICLES. Scientific Report No. 2. Edward Gerjuoy (Plesset (E. H.) Associates, Inc., Los Angeles). Oct. 17, 1960. 38p. Contract AF19 (604)-6187.

A review is given of the formal theory used to compute reaction rates resulting from arbitrarily complicated collisions between "aggregates" of spinless distinguishable particles, with special reference to atomic and molecular collisions of interest. This restricted theory serves as an introduction to the more realistic and more complicated case of collisions between systems of indistinguishable particles possessing spin. (auth)

5575 (JINR-D-531) ON DETERMINATION OF RELATIVE PARITY OF Σ^0 AND Λ^0. B. N. Valuev (Valuyev) and B. V. Geshkenbein (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 6p.

The correlation between the polarizations of Σ^0 and Λ^0 particles and an electron-positron pair in the reaction $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ is treated depending upon the relative parity of Σ^0 and Λ^0. The correlations for positive and negative relative parity are essentially different. If it is possible to get polarized Σ^0 particles, the measurement of the above correlation may turn out to be a comparatively convenient way for determining the relative parity of Σ^0 and Λ^0. (auth)

5576 (JINR-D-570) DEPOLARIZATION PROCESSES OF NEGATIVE MUONS. A. E. Ignatenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 18p.

On the basis of measurements of the asymmetry of $(\mu\text{-}e)$-decay electrons the depolarization processes of negative muons in different matters were studied with scintillation counters. It was found that most essential muon depolarization takes place after their slowing down in mesic atom production. It is shown that reasons causing muon depolarization in a mesic atom are the following: (a) spin-orbital interaction leading to the fine structure of energy levels, (b) interaction of muon and nuclear magnetic moments responsible for mesic atom hyperfine structure, (c) muon interaction with quadrupole nuclear distortion, and (d) interaction of muon magnetic moment with the magnetic field of the electron shell. The principal peculiarities of each depolarization process are described. (auth)

5577 (JINR-D-571) ON THE SECONDARY PROCESSES IN PION PRODUCTION ON NUCLEI. V. M. Maltsev and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 9p.

The calculation of pion production in p-C collisions at 660 Mev was performed by the Monte Carlo method. It is shown that pion scattering (with charge-exchange) changes essentially pion angular distributions and the ratio of positive and negative pion yields. The obtained angular dependence of this ratio is in agreement with experimental data. (auth)

5578 (JINR-D-577) ON HIGH ENERGY NEUTRINO PHYSICS. Reports on JINR Seminars (1957-1960). (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1960. 95p.

Thirteen papers are presented on high-energy neutrino physics covering such topics as electron and muon neutrinos, intermediate boson in weak interactions, neutrinos emitted by mesons, mesonium and antimesonium, universal Fermi interaction, weak interactions, limit applicability of quantum electrodynamics, photoproduction of ν-$\bar{\nu}$ pairs on electrons, generation of fast neutrino beams, interaction of neutrinos produced by parallel monochromatic beams of π-mesons, and high-energy approximations for weak four-fermion interactions. (W.D.M.)

5579 (JINR-D-578) PROBLEMS OF MAJORIZATION OF FEINMAN DIAGRAMMS. N. A. Chernikov, A. A. Logunov, and I. T. Todorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 97p.

An extension of the majorization method of Symanzik is considered. A means is worked out for finding the so-called primitive diagrams, such that any diagram is majorated by one of the primitive diagrams. By expressing the quadratic form of the diagram in terms of the incident matrix, a generalization of Symanzik's theorem is obtained. The method is applied to the vertex and to the scattering processes involving nucleons and scalar mesons. (W.D.M.)

5580 (JINR-E-528) THE METHOD OF CALCULATING STATISTICAL WEIGHTS AND DISTRIBUTIONS IN THE THEORIES OF MULTIPLE PRODUCTION. G. I. Kopylov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 32p.

An effective method of calculating distributions and correlations in the arbitrary models of the multiple production was found. The formulas are especially simple for the covariant model. It is shown how the study of this model can facilitate calculations in more complicated models. (auth)

5581 (JINR-E-542) ON THE POLARIZATION CROSS-SECTION OF FAST NUCLEON SCATTERING. S. Ciulli and J. Fischer (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 4p.

Polarization measurements in elastic small-angle scattering of fast nucleons are considered. The theoretical interest in measurements on recoil protons is discussed briefly. (W.D.M.)

5582 (NP-9617) SCATTERING OF 2 Bev/c MUONS IN CARBON AND LEAD. G. E. Masek, L. D. Heggie, Y. B. Kim, and R. W. Williams (Washington. Univ., Seattle). [1960]. 51p. Contract Nonr-477(12).

The scattering cross section of high energy μ mesons in carbon and lead was measured, using a pure, monoenergetic beam of muons obtained with the Bevatron. Preparation, purification, and measured properties of the beam are described. The median momentum was 2.00 ± 0.03 Bev/c; the spread in momentum was not more than $\pm 3.5\%$; and the effective contamination due to pions was 4.9×10^{-4}. During the experiment the total number of muons incident on the apparatus was 2.5×10^{9}. Counter hodoscopes recorded the muons scattered from 14.4 g/cm^2 of lead and from 27 g/cm^2 of carbon. Inelastic as well as elastic processes were accepted. Scattered particles were observed at angles up to 12° (momentum transfer ~400 Mev/c). The lead data cover the same range as those cosmic-ray experiments that have appeared to indicate an anomalously large scattering. No anomaly is found; the lead scattering agrees closely with the distribution calculated by Cooper and Rainwater for purely electromagnetic interactions. The carbon data permit a better comparison with theoretical expectations, since the single-scattering cross section is measured directly and the effects of nuclear structure can be accounted for rather accurately, using electron scattering data and a detailed theoretical analysis of Drell and Schwartz. The carbon scattering results, based on 300 events in the region 70 to 400 Mev/c momentum transfer, agree closely with the Drell-Schwartz theory. The upper limits that this result places on a nonelectromagnetic scattering cross section and on a muon form factor are discussed. (auth)

5583 (UCRL-6124) PRACTICAL UTILIZATION OF THE NEAREST SINGULARITY IN DISPERSION RELATIONS. Michael J. Moravcsik (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1960. 59p. Contract W-7405-eng-48. OTS.

Lectures presented at the Scottish Universities' Summer School in Physics (a NATO Advanced Institute), Edinburgh, August 1960.

Applications of some aspects of dispersion theory as applied to elementary particle physics are discussed in a series of lectures. The lecture topics center around the utilization of the properties of the singularities in the dispersion relation that lie closest to the physical region. Six lectures are included. (J.R.D.)

5584 NEUTRINO INTERACTIONS. Frederick Reines (Case Inst. of Tech., Cleveland). Ann. Rev. Nuclear Sci. 10, 1-26(1960).

A survey is given of literature on the detection of free neutrino interactions. The Los Alamos experiments conducted to show the independent existence of the neutrino and to show that it could be detected away from the site of creation are discussed. These experiments indicated that the value of the interaction cross section was also of interest. Two types of low-energy interactions are discussed: inverse beta (β^-) decay and the elastic scattering of antineutrinos by electrons. An indication is given of how high-energy neutrino beams might be produced from an incident proton beam in the multi-Bev range on a target in which a multiplicity of pions is produced. An example of the experimental conditions associated with high-energy experiments is illustrated by considering the condition in which the object is to demonstrate the existence of neutrino-like particles through an absorption process. The possibility of studying cosmic-ray phenomena through the weak interactions of neutrinos is discussed. The cosmic neutrino and its interest to cosmology also are discussed. 50 references. (B.O.G.)

5585 OPTICS OF HIGH-ENERGY BEAMS. Owen Chamberlain (Univ. of California, Berkeley). Ann. Rev. Nuclear Sci. 10, 161-92(1960).

A survey is given of literature pertaining to the methods for setting up high-energy beams of charged secondary particles. The simplest system for forming the beam involves the use of magnetic fields only. Some comments are given concerning the use of electric fields in conjunction with the magnetic field. Such an inclusion results in a separation of the beam into its various components according to the velocities of the particles, hence, according to the particle masses. The survey includes discussions on basic components of purely magnetic systems; focusing properties of magnetic fields; determination of a trajectory in the central plane; matrix methods for combining components; use of wire orbits to test components; measurement of transmission of magnetic beam-forming systems; aberrations; separated beams; examples of purely magnetic systems; and extremely clean collimated beams. 39 references. (B.O.G.)

5586 NUCLEON-NUCLEON SCATTERING EXPERIMENTS AND THEIR PHENOMENOLOGICAL ANALYSIS. M. H. MacGregor, M. J. Moravcsik, and H. P. Stapp (Univ. of California, Livermore and Berkeley). Ann. Rev. Nuclear Sci. 10, 291-352(1960). (UCRL-9281)

A survey was made of literature pertaining to nucleon-nucleon scattering experiments and their phenomenological analyses. A general formalism is described for the description and analysis of the experiments, especially of polarization, triple-scattering, and correlation. Data are collected and presented in graphical and tabular forms. The phenomenological analysis is described with reference to effective-range formalisms and phase-shift analysis. 254 references. (B.O.G.)

5587 ON THE EFFECT OF A MAGNETIC FIELD ON THE SPECTRUM OF INCOHERENT SCATTERING. Thomas Laaspere (Cornell Univ., Ithaca, N. Y.). J. Geophys. Research 65, 3955-9(1960) Dec.

The effect of an applied magnetic field was analyzed at scales of scattering smaller than the Debye length. If the scattering-wave vector is directed everywhere perpendicular to the magnetic-field vector and each electron is assumed to gyrate unperturbed about a magnetic line of force, the spectrum of scattering will, in the first approximation, consist of lines. The separation of the lines is equal to the electron gyromagnetic frequency. If the average radius of gyration of the electrons is large compared to the scale of scattering, the envelope of the line spectrum is given simply by the thermal Doppler-spectrum curve that would exist in the absence of any magnetic field. As the average radius of gyration is decreased, however, an increasing fraction of power appears in the central line. Curves given in this report reveal that the line spectrum gets smeared rapidly as the angle between the scattering-wave vector and the magnetic lines of force is decreased from 90°. (auth)

5588 POLARIZATION OF PROTONS SCATTERED FROM COMPLEX NUCLEI. Shotaro Yamabe, Michiya Kondo, Shohei Kato, Takashi Yamazaki, and Jian-zhi Ruan (Osaka Univ.). J. Phys. Soc. Japan 15, 2154-8(1960) Dec. (In English)

The experimental results for the angular dependence of the polarization of elastically scattered protons from carbon at 14 and 16 Mev and the polarization at 45° laboratory angle in the elastic scattering by 12 target nuclei at the energy of 12 to 17 Mev are described. Qualitative agreement with the calculation in terms of optical potential with spin-orbit interaction is obtained for elastic scattering of protons by carbon. (auth)

5589 THE ENERGY SPECTRA OF SECONDARY ELECTRONS IN VARIOUS MATERIALS IRRADIATED BY GAMMA RAYS FROM ^{60}Co AND ^{137}Cs. Nobuo Oda (Rikkyo (St. Paul's) Univ., Tokyo) and Hirosi Suzuki. J. Phys. Soc. Japan 15, 2365-6(1960) Dec. (In English)

Measurements were made with a scintillation spectrometer. The target materials for the measurements were aluminum, copper, lead, and polyethylene. A description is given of the experimental arrangement including the detection system. The energy spectra from the targets were obtained by subtracting the pulse height spectra measured without target disks from those measured with target disks. The results are shown graphically. The obtained spectra result from electrons traveling into the forward hemisphere past a point in the medium and do not contain electrons scattered in the backward direction. The backward part may be appreciable for the medium with a higher atomic number, such as lead. (B.O.G.)

5590 THE MEAN LIFETIME OF CHARGED Σ-HYPERONS AND INVESTIGATIONS OF FURTHER CHARACTERISTICS OF THESE PARTICLES. W. Püschel (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Phys. 20, 254-74(1960) Oct. (4). (In German)

The apparent discrepancy in the mean lifetime of the Σ hyperons in emulsions was investigated by using decays in flight only and decays both in flight and at rest. All the Σ's came from K^- absorptions from which apart from the Σ

only one fast particle was emitted. For the $\Sigma^+ \rightarrow p + \pi^0$ decay mode using 127 decays at rest and in flight it was found that $\tau = (0.98^{+0.16}_{-0.13}) \times 10^{-10}$ sec. Using the 48 decays in flight only, $\tau = (0.60^{+0.42}_{-0.17}) \times 10^{-10}$ sec. For the mixture of Σ^+ hyperons from decays in flight only by the mode $\Sigma^+ \rightarrow n + \pi^+$ the same maximum likelihood estimates led to $\tau = (0.91^{+0.45}_{-0.19}) \times 10^{-10}$ sec. By combining data from this laboratory (191 decays), Istituto di Fisica Bologna (114) decays, École Polytechnique Paris (74 decays), and Istituto di Fisica Parma (68 decays), it is shown that there is no evidence for a lifetime doublet. Comparison with other data was also made and it was concluded that the best value for the Σ^+-hyperon lifetime is $\tau = (0.95^{+0.07}_{-0.06}) \times 10^{-10}$ sec. Angular distributions in Σ decay were analyzed for information on parity conservation in Σ production. No evidence for a parity nonconservation in Σ production was found. Measurements of the masses of the charged Σ hyperons and the K^- meson are reported. The terminal behavior of the Σ^- hyperons was also studied. (auth)

5591 MULTIPLE PRODUCTION OF MESONS IN PION-NUCLEON COLLISIONS. Wieslaw Czyż (Inst. for Nuclear Research, Krakow) and Sheldon L. Glashow. Nuclear Phys. 20, 309-12(1960) Oct. (4). (In English)

The model of Czyż, Ericson, and Glashow for multiple meson production in energetic nucleon-nucleon collisions is applied to the analogous pion-nucleon process. The angular distributions of the shower particles of such events are predicted to display a single-cone structure, and to be forward peaked in the center-of-mass system at primary energies greater than 400 Bev. The model should be applicable for pion energies beyond 50 Bev. (auth)

5592 OPTICAL MODEL ANALYSIS OF THE SCATTERING OF 96 Mev NEUTRONS BY NUCLEI. P. E. Hodgson (Clarendon Lab., Oxford). Nuclear Phys. 21, 21-7 (1960) Nov. (4). (In English)

Total, absorption, and small-angle elastic differential cross-sections for Li, Be, C, Al, Cu, Cd, Pb, and U are fitted by the optical model. (auth)

5593 SPIN-ORBIT COUPLING FOR SPIN-1 PARTICLES. G. R. Satchler (Oak Ridge National Lab., Tenn.). Nuclear Phys. 21, 116-27(1960) Nov. (4). (In English)

A one-body spin-orbit potential for spin-1 particles may contain, in addition to the familiar vector term $1 \cdot s$ used with spin-$\frac{1}{2}$ particles, certain tensor terms T. The T may be constructed from the position, momentum, and angular momentum vectors of the particle. Time reversal invariance cannot be demanded if a complex potential is allowed, but the requirements of parity conservation and symmetry of the scattering matrix allow only three forms of T. Only one of these remains diagonal in the orbital angular momentum. A simple model illustrates the possible origin of a tensor coupling for deuterons. The implications for the scattering and polarization of spin-1 particles are discussed. (auth)

5594 EFFECTIVE RANGE FOR K^+-NUCLEON INTERACTION FROM DISPERSION RELATIONS. S. N. Biswas and V. Gupta (Tata Inst. of Fundamental Research, Bombay). Nuclear Phys. 21, 137-41(1960) Nov. (4). (In English)

An exact formula for the effective range for K^+-P interaction, in the S-wave approximation, was deduced using dispersion theoretic techniques. It is shown that if the assumption of zero effective range, which is generally used for a phenomenological fit of K−N data, is valid then the analysis clearly indicates that the K-meson-hyperon relative parity must be odd (the $\Sigma-\Lambda$ relative parity being even). The contribution of the dispersion integral over the unphysical region was fully taken into account. A general discussion of the nature of the coupling is given for a nonvanishing but small effective range. The advantage of the use of the effective range formula to determine the sign of the relative parities is also pointed out. (auth)

5595 OPTICAL MODEL ANALYSIS OF NEGATIVE PION-PROTON ELASTIC SCATTERING BETWEEN 1.4 AND 6.8 Gev. G. Domokos and A. Sebestyen (Central Research Inst. for Physics, Budapest). Nuclear Phys. 21, 157-60(1960) Nov. (4). (In English)

Elastic scattering of negative pions on protons is analyzed in terms of an optical model. The rms radius of the absorptive region is found to be $\langle r^2 \rangle^{\frac{1}{2}} = (0.521 \pm 0.016) \cdot 10^{-13}$cm. (auth)

5596 RELATIONS FOR THE ELECTROMAGNETIC SELF-MASSES OF PARTICLES. W. R. Theis (Universität, Hamburg). Nuclear Phys. 21, 170-6(1960) Nov. (4). (In English)

Equations for the electromagnetic self-masses of the first order in the fine structure constant are obtained including all nonelectromagnetic interactions without approximation. (auth)

5597 THERMAL NEUTRON FLUX DISTRIBUTIONS IN SPACE AND ENERGY. Paul Michael (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng. 8, 426-31(1960) Nov. (BNL-4855).

The steady-state space-energy distribution of thermal neutrons in homogeneous media is considered in the diffusion approximation. From the general form of the solution it is shown that the asymptotic (in space) distribution depends upon the source distribution and under different circumstances can be qualitatively different. The relation of the asymptotic flux to the usually found infinite medium spectrum is exhibited. For a heavy gas moderator the asymptotic flux from a source of limited extent is shown to be much softer than an infinite medium spectrum in the same material. (auth)

5598 THE KEMMER β-FORMALISM FOR PARTICLES OF SPIN ONE-HALF. A. O. Barut and M. Samiullah (Syracuse Univ., N. Y.). Nuovo cimento (10) 17, 876-80 (1960) Sept. 16. (In English)

A linearization of the two-component second-order spinor equation of Feynman and Gell-Mann for spin one-half particles leads to a ten-component equation of the Kemmer type. Up to now such equations were only known for integral spin particles. (auth)

5599 SIGN OF THE NUCLEAR POTENTIAL FOR THE K^+-MESON. T. G. Lim and P. G. Van Breemen (Universiteit, Amsterdam). Nuovo cimento (10) 17, 887-92 (1960) Sept. 16. (In English)

The sign of the nuclear potential for the K^+-meson is determined from the small angle distribution of the elastic scattering in G-5 nuclear emulsion. The investigation was carried out in the low kinetic energy region ($\approx$60 Mev). The Born approximation was applied to analyze the data, and it is found that the nuclear potential is repulsive. (auth)

5600 ON THE μ-MESON MASS. H. Kita and E. Predazzi (Università, Turin). Nuovo cimento (10) 17, 908-18(1960) Sept. 16. (In English)

A possibility of explaining the anomalously large mass of the μ-meson by taking account of the high singularity of the weak Fermi interaction is discussed. It is shown that a single spinor field $\binom{\nu}{\mu}$ interacting weakly with a two-

component neutrino field can describe the electron and the μ-meson as its ground and excited states, respectively, by solving an eigenvalue problem which comes from the negativeness of the self-energy of $\overset{(w)}{\psi}$ owing to the adopted weak Fermi interaction and by using an invariant cutoff method. The order of magnitude of the cutoff parameter is about the inverse of the weak coupling constant l_w ($l_w = 6.85 \times 10^{-17}$ cm). The possible importance of the high singularity of the Fermi interaction is emphasized. The problem of the μ-meson decay is also discussed. (auth)

5601 TESTS FOR $\Delta T = \frac{1}{2}$ IN $K^+ \rightarrow 3\pi$ AND $K_2^0 \rightarrow 3\pi$ DECAY MODES. R. F. Sawyer and K. C. Wali (Univ. of Wisconsin, Madison). Nuovo cimento (10) 17, 938-45(1960) Sept. 16. (In English)

The consequences of the $\Delta T = \frac{1}{2}$ selection rule on the energy spectra of the pions in $K^+ \rightarrow 3\pi$, $K_2^0 \rightarrow 3\pi$ decay modes were studied. Without any dynamical assumptions one can conclude that the π^+, π^0 spectra in $K^+ \rightarrow \pi^0 + \pi^0 + \pi^+$ and the π^0, π^+ (or π^-) spectra in $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$, respectively, should be the same. The effect of strong final state π-π interactions on the general structure of the decay amplitude is discussed, and the possibility of detecting experimentally the presence of such strong interactions is suggested. The question of whether the experimental spectra provide a critical test of $\Delta T = \frac{1}{2}$ rule is also considered. (auth)

5602 A NOTE ON THE PROOF OF DISPERSION RELATIONS. A. Minguzzi and R. F. Streater (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 17, 946-50(1960) Sept. 16. (In English)

Lehmann's proof of dispersion relations is completed by showing that the absorptive part of the scattering amplitude is regular in a uniform neighborhood of the real axis as a function of the meson mass. The same point is considered for production processes; one or two other difficulties in the latter case are also discussed. (auth)

5603 HIGH-FREQUENCY REGION OF THE BREMSSTRAHLUNG SPECTRUM. R. H. Pratt (Stanford Univ., Calif.). Phys. Rev. 120, 1717-22(1960) Dec. 1.

The McVoy-Fano theory of the connection between the atomic photoelectric effect and the high-frequency region of the bremsstrahlung spectrum was extended to next order in αZ. The contribution from p states was determined and was important in heavy elements. Predictions for the high-frequency limit are in reasonable agreement with experiment. Information was also obtained concerning angular distributions and polarization correlations. (auth)

5604 MEASUREMENT OF THE ROTATION PARAMETER R IN PROTON-PROTON SCATTERING AT 140 Mev. E. H. Thorndike, J. Lefrançois, and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev. 120, 1819-26(1960) Dec. 1.

The proton-proton rotation parameter R was measured at a laboratory energy of 140.5 Mev over a range of scattering angles θ_2 by means of a triple-scattering experiment. The following values were obtained: θ_2(lab) = 15°, -0.252 ± 0.030; 20°, -0.227 ± 0.028; 25°, -0.271 ± 0.035; 30°, -0.146 ± 0.037; 35°, -0.151 ± 0.055; 40°, -0.047 ± 0.080. (auth)

5605 MEASUREMENTS OF SPATIAL ASYMMETRIES IN THE DECAY OF POLARIZED NEUTRONS. M. T. Burgy (Argonne National Lab., Ill.), V. E. Krohn, T. B. Novey, G. R. Ringo, and V. L. Telegdi. Phys. Rev. 120, 1829-38 (1960) Dec. 1.

A series of experiments was carried out to examine the spatial symmetry properties of the β decay of the free neutron. Measurements of angular distributions of the electrons and protons coming from the decay of polarized neutrons showed that the correlation coefficient between the directions of electron momentum and neutron spin is -0.11 ± 0.02 and that between the antineutrino momentum and the neutron spin is 0.88 ± 0.15. The coefficient of the term proportional to the scalar triple product of antineutrino momentum, electron momentum, and neutron spin (which is not invariant under time reversal) is 0.04 ± 0.05. All these results are consistent with the A−V theory of β decay. Details of measurement techniques and the method of producing a beam of polarized neutrons are given. (auth)

5606 PARTICLE CREATION IN ELECTRON-ELECTRON COLLISIONS. F. Calogero and C. Zemach (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Phys. Rev. 120, 1860-6(1960) Dec. 1.

Pair production in high-energy electron-electron collisions was studied with special attention given to pion pair production. A method of calculation was formulated which yields results with reasonable directness in the relativistic limit. The orders of magnitude of counting rates for various experimental settings were ascertained. A complete result was obtained for the case in which two pions emerge with equal energies and opposite momenta. (auth)

5607 SPIN-ORBIT CORRELATIONS IN μ−e AND e^-−e^- SCATTERING. A. O. Barut and C. Fronsdal (European Organization for Nuclear Research, Geneva). Phys. Rev. 120, 1871-4(1960) Dec. 1.

The imaginary part of the fourth order matrix element for the electromagnetic scattering of two fermions gives rise to a small dependence of the cross section on the quantity $s \cdot p_1 \times k_1$, where s and p_1 are the spin and momenta of one of the initial particles, and k_1 the momentum of the same particle after scattering. The resulting angular asymmetry can probably be measured. The effect does not occur in the lowest order of scattering. (auth)

5608 POSITIVE PION PRODUCTION IN p-p COLLISIONS AT 420 Mev WITH POLARIZED PROTONS. Robert H. March (Univ. of Chicago). Phys. Rev. 120, 1874-80(1960) Dec. 1.

The asymmetry in the production of positive π mesons in p-p collisions was studied, using a 420-Mev, 62% polarized proton beam from the Chicago synchrocyclotron, with nuclear emulsions as the pion detector. The asymmetry at 65° in the laboratory for the entire spectrum above 20 Mev in the center-of-mass system was found to be 0.151 ± 0.021, in the direction opposite the elastic scattering that produced the polarized beam. In the region of the spectrum above 40 Mev, results are consistent with those found by other authors for the reaction $p + p \rightarrow \pi^+ + d$. At lower energies where pions associated with final nucleon p states become predominant, the asymmetry decreases rapidly and may possibly reverse. (auth)

5609 CROSS SECTION AND POLARIZATION IN THE PHOTODISINTEGRATION OF THE DEUTERON. M. L. Rustgi, W. Zernik, G. Breit, and D. J. Andrews (Yale Univ., New Haven). Phys. Rev. 120, 1881-97(1960) Dec. 1.

The differential cross section and polarization of nucleons from the $H^3(\gamma,n)H^1$ reaction was investigated arranging calculations by means of the amplitude method. Electric dipole, electric quadrupole, and magnetic dipole transitions were considered taking into account coupling between states with the same J but different L such as produced by the tensor potential. The calculations included the general case of elliptically polarized γ rays. Numerical results were obtained for two modified versions of the

Signell-Marshak two-nucleon potential. Five approximations were used to exhibit the effects of the various multipole transitions. The calculations agreed with experiment rather well even at energies for which the potential used did not represent scattering data at all perfectly. The significance of polarization measurements is discussed. (auth)

5610 INTERACTION OF K^+ MESONS WITH EMULSION NUCLEI; K^+ ENERGY RANGE 140–375 Mev. B. Sechi Zorn and G. T. Zorn (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 120, 1898-1913(1960) Dec. 1.

Experimental data are presented on the interaction in nuclear emulsions of K^+ mesons in the energy range 140 to 375 Mev. From an optical-model calculation based on a Wood-Saxon potential ($r_0 = 1.15\,A^{\frac{1}{3}}$ f, d = 0.57 f), the real K nuclear potential V was found to be positive (or repulsive), varying from 18.5 ± 3.3 Mev at the lowest energy to 13.5 ± 5.0 Mev at the highest energy. The value of the imaginary nuclear potential W changed with increasing energy from −12.9 ± 1.4 to −17.6 ± 2.5 Mev. The K-nucleon cross section was derived from the imaginary nuclear potential and, under the assumption of the independent-particle model of the nucleus, the total K-neutron noncharge-exchange cross section σ_{Kn^+} and the charge-exchange cross section σ_{Kn^0} were determined. It was found that σ_{Kn^+} decreased with increasing energy from 12.1 ± 1.6 to 8.1 ± 1.5 mb, whereas σ_{Kn^0} increased from 4.6 ± 1.2 to 10.3 ± 2.4 mb. A phase-shift analysis using the total cross sections σ_{Kp^+} (the K-proton cross section), σ_{Kn^0}, $\bar{\sigma}_{ub}$ (the average K-nucleon cross section), and V gave evidence for P-wave contribution in isotopic spin state T = 0 and permitted an investigation of the angular distribution for K^+-neutron scattering. Charged π-meson production by K^+ mesons was observed, and the K-nucleon cross section at ~280-Mev K^+ energy was estimated to be ~1/7 mb. (auth)

5611 SEARCH FOR Σ^- HYPERFRAGMENTS. R. G. Ammar, N. Crayton, K. P. Jain, R. Levi Setti, J. E. Mott, P. E. Schlein, O. Skjeggestad, and P. K. Srivastava (Univ. of Chicago). Phys. Rev. 120, 1914-16(1960) Dec. 1.

A systematic search was undertaken for possible Σ^- compounds produced by K^- captures in nuclear emulsion. Mass determinations were performed on 15 decays in flight into a charged pion and 84 events resulting in capture configurations; the number of these events produced in single-nucleon K^- captures is estimated to be >32 but <71. All events of the first type and all but 4 of the second type were consistent with the interpretation as Σ^-. The 4 events are discussed in detail and it is concluded that, although the (Σ^-n) interpretation cannot be ruled out for 3 of them, in no case is the identification unequivocal. (auth)

5612 GEOMETRIC THEORY OF CHARGE. H. Ekstein (Argonne National Lab., Ill. and Imperial Coll., London). Phys. Rev. 120, 1917-25(1960) Dec. 1.

The symmetry properties of elementary particles—in particular the number of linearly independent states with a fixed mass and momentum—can be explained by relativistic covariance alone, if the irreducible representation assigned to particles with antiparticles is chosen so that it contains 2(2s + 1) linearly independent states for fixed mass and momentum. No nongeometric symmetry element such as charge conjugation is introduced. The existence of superselection rules within these irreducible representations is made necessary by the postulate that time-reversal invariance be directly verifiable. In this representation, the space-inversion operator has the same effect as the product PC in the usual representation. A charge operator Q is defined and it is shown that all physically realizable states are eigenstates of Q with integral eigenvalues. For "simple" particles, Q can have only the eigenvalues 0, ±1. (auth)

5613 COLLECTIVE CORRELATION BETWEEN VACUUM NUCLEONS AND THE S-WAVE PION-NUCLEON SCATTERING. Osamu Hara (Nihon Univ., Tokyo). Progr. Theoret Phys. (Kyoto) 24, 495-511(1960) Sept. (In English)

Scattering of S-wave pion by nucleon was calculated considering the collective correlation between vacuum nucleons. The point is that there can exist a strong collective correlation between vacuum nucleons just as between electrons in metal at the absolute zero of temperature since interaction between vacuum nucleons caused by pions is dominantly attractive. The effect of this correlation was calculated using Bogoliubov's method which was very successful in the theory of superconductivity. The phase shift δ_3 was calculated using Tamm-Dancoff approximation including up to two pions and one nucleon pair. It was shown that by considering this effect, the result of Dyson et al., using the same approximation was improved greatly, and an over-all agreement with experiment was obtained. δ_1 was not calculated. (auth)

5614 FIELD THEORETICAL INTERPRETATION OF "B-MATTER." [PART] I. Hiroshi Yamamoto (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto) 24, 512-18 (1960) Sept. (In English)

The property of "B-matter" which was introduced in the Nagoya model is studied by current field theory. A reasonable interaction, Lagrangian, is assumed between the "B-particle" and leptons, and the following conditions are required: through this interaction, the proton P, the neutron N, and the lambda particle Λ should be constructed as bound states of the "B-particle" and leptons, and the β-decay should occur through the same interaction. Results are summarized as follows: the "B-particle" must have a mass of ~10^5 to 10^6 times electron mass in order that the requirements may be fulfilled. It might be possible to describe the strong and weak interactions (excluding the μ-decay) by means of the interaction in a unified way. (auth)

5615 THE ELECTRIC POLARIZABILITY OF THE NEUTRON. Tamotsu Ueda and Makoto Sawamura (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto) 24, 519-28 (1960) Sept. (In English)

Electric polarizability of the neutron is calculated by relativistic meson theory in the lowest order of perturbation method. A cutoff calculation is examined. There are remarkable cancellations among the large contributions from the pion current so that those from the nucleon currents and from the K-meson interactions become important. The electric polarizability obtained amounts to several times as large as 10^{-43} cm^3 and is expected not to exceed 10^{-42} cm^3. Discussions are made in connection with the Foldy term, static theory, and the problem of mass difference. (auth)

5616 SYMMETRY IN SAKATA'S MODEL AND WEAK INTERACTIONS. [PART] I. Mineo Ikeda, Yoshihiko Miyachi, and Shuzo Ogawa (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto) 24, 569-87(1960) Sept. (In English)

Using the symmetry theory of Sakata's model a study was made of properties concerning various weak interactions. For baryon-meson systems, a scheme is proposed in which a decay can be described by the transitions between various configurations. In this scheme the conventional selection rule concerning isospin can be understood quite naturally. It is also investigated how the symmetry

property possessed by the basic particles is reflected in the β decay of hyperons and in the K_{e3} decay. (auth)

5617 NON-LOCALITY IN THE SECOND ORDER POTENTIAL. Robert L. Carovillano (Boston Coll., Chestnut Hill, Mass.). Progr. Theoret. Phys. (Kyoto) 24, 614-28 (1960) Sept. (In English)

The nonlocal properties of the second-order two-nucleon interaction are investigated using ps-ps meson theory and the Tamm-Dancoff approach. None of the customary transformations are applied to the potential or wave function, so the second order potential derived is both momentum dependent and energy dependent. The potential is hermitian, however, so that the two-nucleon component of the wave function can be normalized in the usual manner, conserving probability. The size of the nonlocal corrections on scattering states is estimated as a function of energy and as a function of the internucleon separation distance. The Born approximation is used to show that the lowest order velocity correction accounts for almost all of the nonlocal corrections at 300 Mev laboratory energy where it decreases the static scattering amplitude by about 25%. The energy dependence of the potential is instrumental for the Born approximation scattering amplitude being the same as given by lowest order S-matrix theory. The nonlocal corrections are estimated as a function of internucleon distance by defining an "effective" scattering potential which disguises most of the velocity terms as a static fourth-order potential. Velocity corrections are found to be very large in triplet states, dominating over the static second-order potential at about 1.5 to 3.0 f. Comparison with potentials of others where various transformations have been employed is discussed. There is no spin orbit component in the second-order ps-ps potential, but the corresponding potential derived from scalar meson theory does have such a component. The latter calculation suggests that a spin-orbit potential should really be regarded as a quadratic momentum dependence and therefore does not have an a priori preference over other admissible quadratic dependences. (auth)

5618 THE HYPERON AND NUCLEON INTERACTIONS. I. POTENTIALS. Masayuki Uehara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 629-47(1960) Sept. (In English)

Two- and three-body Y-N potentials including rescattering corrections are calculated using Miyazawa's method. The Y-N systems are treated by two-channel formalisms for T = 1/2: one is the channel of the Σ-N system and the other is the Λ-N system. Then the potential is defined as the 2 × 2 matrix form. The three-body force vanishes, in which no direct two-nucleon interaction is considered, if the π-Λ rescattering corrections are not considered. The other type of the three-body force in which one pion is exchanged between each pair of the particles is investigated. (auth)

5619 ON A UNIFIED DESCRIPTION OF ELEMENTARY PARTICLES. Mituo Taketani (Rikkyo Univ., Tokyo) and Yasuhisa Katayama. Progr. Theoret. Phys. (Kyoto) 24, 661-78(1960) Sept. (In English)

A scheme of approach to the unified description of elementary particles is proposed, using the "neutrino" and the concept of "charge-on." The electron and muon are considered as two kinds of electrically (ϵ-) charged-on neutrino, and the proton, neutron, and Λ-particle are baryonically (b-) charged-on neutrino, electron, and muon, respectively. The interactions are constructed from the "currents of charge": the fundamental strong interaction is the b-charged and conserved current-current type where the full symmetry among three baryons automatically holds and the fundamental electromagnetic interaction is the ϵ-charged and conserved current-current type (action at a distance), while the weak interactions consist of the ϵ-charge fading current-current type (usually weak), the b-charge fading current-current type, and the b- and ϵ-charge fading current-current type (both are extremely weak). Their relation is considered genetically by using the b-charge-on process and the ϵ-charge-on process. (auth)

5620 CAUSALITY AND LOCAL COMMUTATIVITY. Kunio Yamamoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto) 24, 684-5(1960) Sept. (In English)

It is shown that from the requirement of local commutativity to prove dispersion relations, except for the case where the mass of the bombarding particle is zero, the scattering amplitude t does not satisfy the macroscopic causality discussed previously. Therefore there is no fact denying that the special case exists where the macroscopic causality is a stronger restriction than the local commutativity required for the special commutators in proving dispersion relations. (B.O.G.)

5621 DOUBLET THEORY OF BARYONS AND WEAK INTERACTION. Friedrich Schlögl (Technische Hochschule, Aachen). Z. Physik 160, 347-54(1960) Oct. (In German)

The baryon doublet theory provides a simple scheme for the weak interaction currents of baryons and mesons. In this scheme a (K, K) part of the currents is excluded. On the other side such a part is not necessary to explain the absence of renormalization effects on the vector coupling constant in β decay. (auth)

Nuclear Properties and Reactions

5622 (CRT-987) REDUCED WIDTHS AND ISOTOPIC SPIN IMPURITIES OF THE $\frac{1}{2}$+ STATES OF N^{15}. J. B. French, Syurei Iwao, and Erich Vogt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1960. 41p. (AECL-1136). AECL.

This report is also being issued at the Univ. of Rochester as NYO-9365.

The nuclear reactions $C^{14}(p,n)N^{14}$ and $C^{14}(p,\gamma_0)N^{15}$ for protons of less than 1.6 Mev involves the interference of two adjacent states having the same spin and parity ($\frac{1}{2}$+) but different isotopic spin (T = $\frac{1}{2}$ and $\frac{3}{2}$). By taking into account the effect of other, more distant $\frac{1}{2}$+ levels on the cross section near the interfering pair of levels, the (p,n) cross section can be well fitted from the neutron threshold up to a proton energy of 1.6 Mev and reliable estimates for the reduced width amplitudes of the interfering pair can be obtained, as well as for the physically significant phases of the amplitudes. Since the neutron decay of the T = $\frac{3}{2}$ state is "forbidden," the neutron reduced widths of the close-lying pair lead to a direct measure (4%) of the isotopic spin impurity of the pair. The results found in the cross section analysis are compared to shell model calculations based on the N^{15} wave functions of Halbert and French, and reasonably satisfactory agreement is found. (auth)

5623 (NDA-2133-2) FAST NEUTRON CROSS SECTIONS OF MANGANESE, CALCIUM, SULFUR, AND SODIUM. Second Quarterly Progress Report Covering the Period March 1–May 31, 1960. E. S. Troubetzkoy (Nuclear Development Corp. of America, White Plains, N. Y.). June 30, 1960. 17p. Contract DA18-108-405-CML-295 (Phase II).

Progress is reported on the compilation of neutron cross

section data for manganese, calcium, sulfur, and sodium. Preliminary values are reported for σ_t, $\sigma_{n\gamma}$, $\sigma_{n\alpha}$, $\sigma_n[E,\theta]$, $\sigma_{n'}(E,E')$, $\sigma_{n'\gamma}$ $[E,E_\gamma]$ for manganese and for $\sigma_n[E,\theta]$ for sodium. (For preceding period see NDA 2133-1.) (auth)

5624 (NP-9376) BIBLIOGRAPHY OF PHOTONUCLEAR REACTIONS. Bibliography No. 18. M. Elaine Toms, Comp. (Naval Research Lab., Washington, D. C.). Oct. 1960. 126p.

Revision of Bibliographies No. 2 and No. 14.

A bibliography containing 1104 references is presented on photonuclear reactions in which a nucleon, or nucleons, are emitted. Photon absorption studies and studies relating to bremsstrahlung spectra and intensity are included. (C.J.G.)

5625 THE THEORY OF NUCLEAR FISSION. I. THE NUCLEAR FORCE INTERACTION BETWEEN THE FRAGMENTS. Witlof Brunner and Harry Paul (Kernphysikalisches Institut, Deutsche Akademie der Wissenschaften, Zeuthen bei Berlin). Ann. Physik (7) 6, 267-78(1960). (In German)

The Fong-Newton theory of nuclear fission was modified by the explicit consideration of the nuclear forces which are still effective between the fragments after their separation. The fission process occurs over a virtual level of the two-particle system of both fragments whose height was determined from the experimentally known values of the mean kinetic energy of the fragments. The relative fission probability was identified with the penetration probability of the potential threshold arising through the interplay of the nuclear and Coulomb forces. Through the requirement that the theory reproduce the mass distribution appearing in the fission, the values thus obtained lie in the order of magnitude to be expected; their variation with the ratio of the masses of both fragments appears to be connected with the development of closed shells in the fragments. (tr-auth)

5626 NUCLEAR INTERACTIONS OF HEAVY IONS. A. Zucker (Oak Ridge National Lab., Tenn.). Ann. Rev. Nuclear Sci. 10, 27-62(1960).

A survey is given of literature pertaining to the field of heavy-ion reactions. Many types of reaction experiments have been performed: scattering studies; evaporation-type reactions; transfer reactions (called stripping or pickup in other fields); fission; Coulomb excitation; and the wide variety covered by the blanket heading, nuclear chemistry. The experimental results are presented; and it is shown how the results were, or may be, interpreted theoretically. A discussion is given of the characteristics of heavy ions in nuclear interactions. 98 references. (B.O.G.)

5627 NUCLEAR STRUCTURE EFFECTS IN INTERNAL CONVERSION. E. L. Church (Frankford Arsenal, Philadelphia) and J. Weneser. Ann. Rev. Nuclear Sci. 10, 193-234(1960). (BNL-4757)

A survey is given of literature pertaining to internal conversion effects in connection with the determination of nuclear structures. Current interest in internal conversion lies in the observation and study of dynamic penetration effects, with the object of uncovering a new body of nuclear information. Discussions are given on the formulation of the interaction between the electron and the nuclear transition currents and charges in an electromagnetic field; static effects of nuclear structure; the dynamic effects in electric and magnetic transitions in penetration matrix elements and nuclear models; and electric-monopole transitions. 64 references. (B.O.G.)

5628 RECOIL TECHNIQUES IN NUCLEAR REACTION AND FISSION STUDIES. B. G. Harvey (Univ. of California, Berkeley). Ann. Rev. Nuclear Sci. 10, 235-58 (1960). (UCRL-9151)

A survey is given of literature pertaining to recoil techniques in connection with fission and nuclear reaction studies. Discussions are included on experimental methods in fission and spallation studies; range-energy relations; and the calculations necessary to convert the recoil kinetic energy or angular distribution measured in the laboratory system into the center-of-mass system. The techniques are improving rapidly, but it is evident that better range-energy relations and a better understanding of scattering are urgently needed. 79 references. (B.O.G.)

5629 THEORETICAL INTERPRETATION OF ENERGY LEVELS IN LIGHT NUCLEI. I. Talmi and I. Unna (Weizmann Inst. of Science, Rehovoth, Israel). Ann. Rev. Nuclear Sci. 10, 353-424(1960).

A survey was made of literature pertaining to theoretical interpretations of energy levels in light nuclei, using collective and shell models. A description is given of the mathematical framework of the shell model, and a comparison of the theoretical predictions with the experimental data is made. The calculation of energy levels and the transitions between nuclear states in nuclei are discussed, but the shell-model description of nuclear reactions is not discussed. Quantitative results are mentioned wherever they were obtained; but where no quantitative results were carried out, the predictions of the model are described qualitatively. Isobaric level schemes of the light nuclei are presented as an appendix. 73 references. (B.O.G.)

5630 A STUDY OF THE $Be^9(d,n)B^{10}$ REACTION BY MEANS OF NUCLEAR EMULSIONS. Elis Hjalmar and Hilding Slätis (Nobel Inst. of Physics, Stockholm). Arkiv Fysik 18, 193-208(1960). (In English)

The energy distribution of neutrons from the $Be^9(d,n)B^{10}$ reaction for 7-Mev deuterons was studied by means of nuclear emulsions. Only 90° scattered neutrons were investigated. The existence of an excited level of about 3.1 Mev roughly confirms the 2.88-Mev level found by Reid and the 2.95-Mev level observed by Génin. Because of the high neutron background from the gold backing for neutron energies below about 4 Mev, the mean measurements were concentrated on neutron energies ≥ 4 Mev. The energy distribution of neutrons from the $Au^{197}(d,n)Hg^{198}$ reaction, thick gold target, is given. Equipment for measuring the deuteron energy distribution of the internal cyclotron beam by means of nuclear emulsions was constructed and used. The new microscope mechanical object stage described earlier proved to be very useful, making possible more accurate and much faster measurements than before. (auth)

5631 BETA-GAMMA DIRECTIONAL CORRELATION IN DECAY OF Ag^{111}. J. H. Hamilton, B.-G. Pettersson, and J. M. Hollander (Univ. of Uppsala). Arkiv Fysik 18, 273-81 (1960). (In English)

The directional correlation between the once-forbidden, nonunique 690-kev β group and the 340-kev γ ray in the decay of Ag^{111} was measured as a function of β energy from 153 to 595 kev. A magnetic lens spectrometer was used as the β analyzer. The observed correlation is nearly isotropic. The anisotropy increases in a negative direction from ~ 0 at 150 kev to -0.023 ± 0.005 at 595 kev. A comparison with theory indicates that cancellation among the nuclear matrix elements governing the β decay is required to explain the small anisotropy. The energy dependence of the correlation indicates that second order terms should be included in the theoretical analysis. This is in agreement with the nonstatistical shape observed for the 690-kev β group. (auth)

5632 THE DECAY OF Pm^{149}. Agda Artna and Margaret E. Law (McMaster Univ., Hamilton, Ont.). Can. J. Phys. 38, 1577-85(1960) Dec.

The 52.8-hr activity of Pm^{149} was investigated using a high resolution β spectrometer, a lens type coincidence spectrometer, and a scintillation spectrometer in conjunction with a multichannel analyzer. The β spectrum was found to consist of two groups with maximum energies of 1.072 ± 0.002 and 0.786 ± 0.004 Mev and intensities of 97.1 ± 0.4 and 2.9 ± 0.4%, respectively. A γ ray of energy 285.7 ± 0.3 kev was found to be in coincidence with the 0.786 Mev β group. No other γ rays with intensities greater than 0.1% were found. The K conversion coefficient for the 286 kev transition was measured to be 0.075 ± 0.008. This together with the values of 6.5 ± 0.7 and 4 ± 1 obtained for the K/L and L/M conversion ratios, respectively, indicate that this transition is M1 in character with less than 10% E2 admixture. (auth)

5633 THE IDENTIFICATION AND HALF LIVES OF FISSION-PRODUCT Rb^{92} AND Rb^{93}. K. Fritze and T. J. Kennett (McMaster Univ., Hamilton, Ont.). Can. J. Phys. 38, 1614-22(1960) Dec.

The existence of two new rubidium isotopes, Rb^{92} and Rb^{93}, was established and their half lives measured. The half lives of these short-lived fission products were determined using a technique of timed precipitations. The values obtained for Rb^{92} and Rb^{93} were 5.3 ± 0.5 sec and 5.6 ± 0.5 sec, respectively. The half lives of the strontium and yttrium daughters were also determined. The strontium isotopes were studied by observing the decay rate of a characteristic γ-ray peak. For Sr^{92} the decay of the 1.37 Mev line gave a value of 2.71 ± 0.02 hr. A γ-ray peak at 590 kev, which was found to be associated with Sr^{93}, decayed with a half life of 7.54 ± 0.06 min. The half lives of the yttrium daughters were determined by β counting. The values found for Y^{92} and Y^{93} were 3.53 ± 0.02 and 10.1 ± 0.1 hr, respectively. (auth)

5634 THE "REACTOR" NEUTRON CAPTURE CROSS SECTION OF Y^{91}. Gwen M. Milton and W. E. Grummitt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys. 38, 1690-1701(1960) Dec. (AECL-1135)

A high specific activity source of Y^{91}, freed from natural uranium and rare earths, was irradiated in a high flux position in the NRX reactor. After further chemical purification, 3.6-hr Y^{92} was identified in the sample by measurement of the 3.6-Mev β particle associated with its decay, using a scintillation spectrometer. Two such measurements established the reactor neutron capture cross section of Y^{91} to be 1.4 ± 0.3 barns. (auth)

5635 STUDY OF THE CRITICAL SCATTERING OF NEUTRONS BY IRON. M. Galula, B. Jacrot, and J. P. Mangin. Colloq. nationaux centre natl. recherche sci. (Paris), p.117-29(1957). (In French). (CEA-1101)

The critical scattering of very slow neutrons by iron near the critical point was measured by time of flight techniques. The Van Hove formula was verified and the geometrical parameters K_1 and r_1 introduced in this theory were determined. (auth)

5636 CALCULATION OF CORRELATION BETWEEN SPINS IN A MAGNETIC SUBSTANCE. P. G. de Gennes. Colloq. nationaux centre natl. recherche sci. (Paris), p.131-7(1957). (In French) (CEA-1098)

An elementary calculation was made of the correlation between spins in a magnetic substance, particularly of their asymptotic form with regard to relatively wide-spaced spins. This permitted the determination of the phenomenological parameters introduced by Van Hove to describe the magnetic scatter of neutrons in the critical opalescent area. (auth)

5637 EXCITATION CURVES AND CROSS SECTIONS OF Li(t,n) REACTIONS FROM 100 TO 300 KEV. Raymond Seltz and Denise Magnac-Valette. Compt. rend. 251, 2006-8(1960) Nov. 7. (In French)

With the aid of a 300-kv accelerator, the yields of the Li(t,n) reactions at low energy were determined between 100 and 300 kev. Up to the present the lowest point studied was that of Crews at 250 kv. The variation of the cross section of Li^6(t,n) is monotonous, while that of Li^7(t,n) has a resonance at 240 kev. (tr-auth)

5638 NEW ISOMERIC STATES OF SPHERICAL EUROPIUM NUCLEI WITH AN ODD MASS NUMBER. E. E. Berlovich, V. N. Klement'ev, L. V. Krasnov, M. K. Nikitin, and I. Yursik (Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 789-92 (1960) Aug. 1. (In Russian)

Previous studies indicate some analogous features in the energy levels of Eu^{147}, Eu^{149}, and Eu^{151}. It is assumed that all three have an $h_{11/2}$ level which initiates in Eu^{147} a M2 transition and in Eu^{149} an E3 transition. The coincidence method was used in analyzing the schemes and lifetimes of isomer levels at 624, 496, and 197 kev. (R.V.J.)

5639 RELATIVE YIELD AND ENERGY DISTRIBUTION OF PHOTODEUTERONS FROM COPPER. A. P. Komar, E. D. Makhnovskiĭ, and V. P. Poddubnov (Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 133, 797-9(1960) Aug. 1. (In Russian)

The ratio of photodeuteron and photoproton yields from copper and their energy distributions at a maximum γ energy of 70 Mev was measured. Photoplates were distributed around the target in such a way that angular distributions of spallation products could be continuously recorded in an angle range θ of 20 to 160°. The experiments were conducted at θ magnitudes from 20 to 50°. The mean angle of particle entrance into the emulsion ξ was 15°. The reaction chamber was placed in a uniform magnetic field of 11,500 gauss, perpendicular to the photoparticle emissions recorded by 400-μ-thick nuclear emulsions. The track-pulse analysis and the "error regions" are plotted and the energy spectrum of "pure" deuterons is shown. The yield ratio of deuterons and protons at 4 to 10 Mev is $Y(\gamma,d)/Y(\gamma,p) = 0.07 \pm 0.04$ and at 3 to 4 Mev $Y(\gamma,d)/Y(\gamma,p) \geq 0.08 \pm 0.04$. (R.V.J.)

5640 EXCITATION FUNCTIONS FOR ALPHA-PARTICLE REACTIONS ON Fe^{56} AND Fe^{57}. Shigeo Tanaka, Michiaki Furukawa, Shiro Iwata, Masuo Yagi, Hiroshi Amano, and Takashi Mikumo (Tokyo Univ.). J. Phys. Soc. Japan 15, 2125-8(1960) Dec. (In English)

Excitation functions for the (α, pn), (α, p2n), (α, 3n), and (α, αpn) reactions on Fe^{56} and the (α, αp) reaction on Fe^{57} were measured by the activation method using a stacked-foil technique; the α-particle energies ranged from 17 to 40 Mev. The measured excitation functions for the α-particle reactions on Fe^{56} were compared with those for the proton reactions on Co^{59}; the compound nucleus Ni^{60} was the same for two cases. The comparison gives a test of the validity of compound nucleus theory. The ratios of corresponding cross sections seem to agree well with the theory (except in the case of resulting Co^{57}). It may be seen that the two curves corresponding to the same residual nucleus in each case do not entirely coincide in energy. (auth)

5641 MULTIPOLARITY OF γ-RAY ABSORPTION IN $U^{238}(\gamma, f)$ REACTION PRODUCED BY $F(p,\alpha\gamma)\gamma$ RAYS. Eiko Takekoshi (Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan 15, 2129-36(1960) Dec. (In English)

Multipolarity of γ-ray absorption in a $U^{238}(\gamma, f)$ reaction, produced by monochromatic γ rays from $F(p, \alpha\gamma)$ reactions, was investigated by the analysis of the angular distribution of 1018 tracks of fission fragments in uranium-impregnated nuclear emulsions. It can be explained by mixing two sorts of interaction: electric dipole (E1) and electric quadrupole (E2). The ratio of E2 to E1 absorption cross section, denoted by σ_{fq}/σ_{fd}, was found to be 0.13 ± 0.05. This value is compared with other results with bremsstrahlung. The angular distribution is consistent with those of Baz et al.; however, the analysis and interpretation of the results are different from those of Baz et al. (auth)

5642 SEARCH FOR WEAK GAMMA-RAYS IN THE POSITRON DECAY OF Mn^{51}. Masao Nozawa (Osaka Univ.), Hisashi Yamamoto, Yasukazu Yoshizawa, and Yujiro Koh. J. Phys. Soc. Japan 15, 2137-9(1960) Dec. (In English)

Weak γ rays following the decay of Mn^{51} were investigated by a NaI(Tl) scintillation spectrometer. To eliminate the effect of the strong annihilation γ ray, a new method was used. Gamma rays of 0.74 and 1.17 Mev were found and these intensities were 0.4 ± 0.2 and $0.2 \pm 0.1\%$ of the positrons, respectively. The half life of Mn^{51} was determined as 44 ± 1 min. (auth)

5643 BETA- AND GAMMA-RAY SPECTROSCOPY OF Mn^{52} AND Mn^{52m}. Toshio Katoh (Osaka Univ.), Masao Nozawa, Yasukazu Yoshizawa, and Yujiro Koh. J. Phys. Soc. Japan 15, 2140-53(1960) Dec. (In English)

Excited levels of Cr^{52} were studied by investigating the decays of Mn^{52}(5.7 days) and Mn^{52m}(21 min), produced by $Cr^{52}(d, 2n)Mn^{52,52m}$. By means of a two-directional focusing β-ray spectrometer, NaI(Tl) scintillation spectrometers and a 20-channel pulse height analyzer, the following results were obtained: energies of the main three gamma rays from Mn^{52} are 746.8 ± 0.2, 938.1 ± 0.4, and 1434.7 ± 0.8 kev; the maximum energies of the positrons from Mn^{52} and Mn^{52m} are 0.572 ± 0.006 and 2.61 ± 0.03 Mev, respectively; the spins and parities of the levels of 3120, 2373, and 1435 kev were determined to be 6+, 4+, and 2+, from measurements of conversion electrons and angular correlations, several weak γ-rays were found, which could be inferred to belong to these decays; the half-life of Mn^{52m} is 21 ± 1 min, and its branching ratio $IT/(\beta^+ + EC)$ was determined as $2 \pm 1\%$; and the energy of isomeric transition is 0.383 ± 0.003 Mev, which was decided as E4 from K/L + M and the transition probability. (auth)

5644 REACTIONS OF NICKEL WITH ALPHA-PARTICLES. Shigeo Tanaka (Tokyo Univ.). J. Phys. Soc. Japan 15, 2159-67(1960) Dec. (In English)

Excitation functions for the α-particle reactions on Ni^{58}, Ni^{60}, Ni^{61}, Ni^{62}, and Ni^{64} were measured at incident energies up to 40 Mev. The sum of the measured cross sections for Ni^{58} appears to agree with the total reaction cross section calculated from the continuum theory for $r_0 = 1.7 \times 10^{-13}$ cm. The sum almost agrees with the optical-model analysis of the reaction cross section for α-particles by Igo, whose prediction seems to give a little higher value. In the excitation function, for the $(\alpha, \alpha n)$ reaction on Ni^{58}, there is a small "knee" immediately after the effective threshold (around 23 Mev). The α-particle reactions on Ni^{60} were compared with the proton reactions on Cu^{63}, the compound nucleus Zn^{64} being the same for two cases. The prediction from the compound nucleus theory seems to hold roughly, and it seems inadequate to discuss strictly whether the discrepancy in energy is significant. The same is observed in the comparison between the α-particle reactions on Ni^{62} and the proton reactions on Cu^{65}. (auth)

5645 EXCITATION FUNCTION FOR THE REACTION $B^{11}(p, n)C^{11}$ UP TO E_p = 15 Mev AND ENERGY LEVELS OF C^{12}. Michiaki Furukawa, Yoshihide Ishizaki, Yoshihiro Nakano, Tadashi Nozaki, Yoshio Saji, and Shigeo Tanaka (Tokyo Univ.). J. Phys. Soc. Japan 15, 2167-70(1960) Dec. (In English)

Excitation function for the $B^{11}(p, n)C^{11}$ reaction was measured by the activation method with improved energy resolution for the proton energies of 4.7 to 15.0 Mev. The excitation function exhibited rather clear peaks at proton energies of 8.5, 9.9, 10.9, 11.5, and 13.6 Mev in the laboratory system and a broad peak at the energy region between 13.8 Mev and 14.5 Mev. A considerable number of uncertain peaks were observed. The excitation function for the $O^{16}(p, \alpha)N^{13}$ reaction was obtained above E_p = 9.7 Mev. (auth)

5646 THE $N^{14}(d, n)O^{15}$ REACTION IN THE ENERGY RANGE FROM 1.5- TO 2.9-Mev. Susumu Morita, Nawoyuki Kawai, Yorio Gotô, Takashi Maki, and Masahiro Mukae (Kyushu Univ., Fukuoka). J. Phys. Soc. Japan 15, 2170-5(1960) Dec. (In English)

The angular distributions of neutrons emitted from the $N^{14}(d, n)O^{15}$ reactions were investigated by means of a neutron detector made of a thin plastic scintillator to eliminate the γ-ray background at the deuteron energies of 1.53-, 1.72-, 1.96-, 2.24-, 2.54-, 2.65_5-, and 2.90-Mev. The results were compared with the stripping theory including the heavy particle stripping, and qualitative agreements were obtained. The excitation curve of this reaction was estimated and compared with those of the $N^{14}(d, p)N^{15}$ and $N^{14}(d, \alpha)C^{12}$ reactions. The excitation curves of the $N^{14}(d, n)$ and $N^{14}(d, p)$ reactions show similar resonance-like structures, whereas that of the $N^{14}(d, \alpha)$ reaction shows somewhat different behavior. (auth)

5647 GAMMA RADIATION FOLLOWING THE DECAY OF Dy^{165}. Akira Hashizume, Tan Takahashi, Yoshihiko Tendo, and Yohko Enomoto (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Japan 15, 2175-8(1960) Dec. (In English)

The transition of γ-rays in Ho^{165} emitted in the decay of Dy^{165} (140 min) was studied with γ-γ coincidence and sum coincidence techniques. In addition to previously reported γ-rays, (178), ~483, and ~515 kev γ-rays are found in coincidence experiment. About 1 Mev γ-rays are resolved into 998 and 1055 kev γ-rays. A proposed decay scheme is presented. The measured half life of Dy^{165} is 142.4 ± 0.5 min. (auth)

5648 DECAYS OF PHOTOREACTION PRODUCTS OF SELENIUM. Tokihiro Kuroyanagi (Tohoku Univ., Sendai). J. Phys. Soc. Japan 15, 2179-87(1960) Dec. (In English)

The decay properties of Se^{73m}, Se^{81}, and As^{73} were studied by scintillation methods. Gamma-ray spectra showed lines of energy 170, 275, 335, 410, 480, 550, 650, and 840 kev belonging to the decay of Se^{81}. The decay scheme of Se^{81} was proposed with the aid of single and coincidence measurements of radiations. The mass difference between the ground states of Se^{81} and Br^{81} is represented by the 1.56-Mev β ray. In As^{73}, new gamma rays of 360, 440, 725, and 890 kev were found. Beta-gamma and gamma-gamma coincidence measurements confirmed that a 44-min activity in selenium is attributed

to Se^{73m}. It is found that the β-decay energy is 1.86-Mev and that there is no appreciable γ ray. (auth)

5649 ^{8}Li EMISSION FROM NUCLEAR DISINTEGRATIONS PRODUCED BY 4.3 Gev NEGATIVE π-MESONS. Masaomi (Takahata) Ohta (Osaka City Univ.). J. Phys. Soc. Japan 15, 2187-90(1960) Dec. (In English)

Fifty-five Li^8 fragments from heavy element disintegrations produced by 4.3 Bev negative π-mesons were found. The frequency, the energy, and the angular distributions of these Li^8 fragments were compared with those of the fragments produced by a 5.7 Bev proton beam reported by Goldsack et al. No appreciable difference was found between the two cases. Of light-element disintegrations, the frequency of Li^8 fragments was found to be about 0.006. (auth)

5650 HYPERFINE STRUCTURE OF THE SPECTRA OF Pr I AND Pr II. Kiyoshi Murakawa (Tokyo Univ.). J. Phys. Soc. Japan 15, 2306-9(1960) Dec. (In English)

In the spectrum of Pr I, three lines were classified and the hfs was measured, from which the interval factor of the level $4f^36s^2\ ^4I_{11/2}$ was determined. From this and the known interval factor of $4f^36s^2\ ^4I_{9/2}$, it was concluded that the value of a_{4f} determined from the hfs of Pr II is also appropriate for Pr I. The configuration $4f^2(^4I)6s$ of Pr II was treated as being of intermediate coupling, and the hfs led to a reasonable value of a_{4f} and a(6s). From the value of a(6s), the magnetic moment of Pr^{141} was calculated to be 4.0 ± 0.2 n.m. (auth)

5651 MEASUREMENTS OF β DECAY AND NUCLEAR ISOMERS USING THE ANTHRACENE-SPLIT CRYSTAL SPECTROMETER. Klaus-Werner Hoffmann (Universität, Göttingen, Ger.). Nachr. Akad. Wiss. Göttingen, II. Math.-physik. Kl. No. 13, 273-93(1960). (In German)

The anthracene split-crystal spectrometer is a special design of a scintillation spectrometer in which the preparation to be studied is placed between the two halves of a split anthracene crystal. It has in addition to the usual arrangements numerous improvements, and it is especially well-suited for β spectroscopy. Using this instrument, many important nuclear physics problems were worked on. Continuous β spectra were studied both in shape and maximal energy, also electron line spectra were measured for determination of conversion coefficients, and several nuclear level schemes were determined. Studies have also been conducted with positrons and α-particles. In particular, the K/L + M + N ratio and half life can now be measured for Dy^{165m} using the anthracene split-crystal spectrometer. The results compare with those of earlier studies; the measuring accuracy can still be increased considerably. (tr-auth)

5652 ENERGY LEVELS AND CONFIGURATION INTERACTION IN Zr^{90} AND RELATED NUCLEI. I. Talmi and I. Unna (Weizmann Inst. of Science, Rehovoth, Israel). Nuclear Phys. 19, 225-42(1960) Oct. (3). (In English)

Proton and neutron $p_{1/2}$ and $g_{9/2}$ configurations (and in particular the interaction of the two 0^+ states in Zr^{90}) are considered without any specific assumptions on the two-body nuclear interaction and radial functions. Matrix elements of the effective nuclear interaction are determined by the analysis of energy levels in Zr^{90} and several neighboring nuclei (e.g., Sr^{88} which has the same configurations). Good agreement is obtained between calculated and experimental level spacings. The one non-diagonal matrix element is determined along with the diagonal elements and the amount of admixture is calculated in all cases. The ground state of Zr^{90} is found to be 75% in the $p^2_{1/2}$ configuration and 25% in the $g^2_{9/2}$ configuration in agreement with the rough experimental findings. The seniority is found to be a good quantum number for the effective interaction obtained in the $g_{9/2}$ shell of identical nucleons. This interaction gives rise to the low-lying $7/2^+$ level in Sr^{85}. Level schemes predicted by the present calculation are given for several nuclei. (auth)

5653 DECAY OF Y^{88}. M. K. Ramaswamy and P. S. Jastram (Ohio State Univ., Columbus). Nuclear Phys. 19, 243-7(1960) Oct. (3). (In English)

The weak positon spectrum in the decay of 105-day Y^{88} was measured in coincidence with the 1.86-Mev γ ray and annihilation radiation. The spectrum has an end-point energy of 560 ± 30 kev. The spectral shape is found to be characteristic of a unique first-forbidden transition (ΔJ = 2, yes), thus confirming a 4^--spin assignment for the ground state of Y^{88}. A search was made for a possible 0^+ excited level below the 1.86 Mev (2^+) level in Sr^{88}, with negative results. An upper limit of 100 kev can be set on any possible E2 transition to such a state. (auth)

5654 COMPARISON OF THE THEORY OF NON-AXIAL NUCLEI WITH EXPERIMENTS. E. P. Grigor'ev (Grigoriev) and M. P. Avotina (Leningrad Univ.). Nuclear Phys. 19, 248-63(1960) Oct. (3). (In English)

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 22384.

5655 ON THE THEORY OF p-α SCATTERING. A. Herzenberg (Univ. of Manchester, Eng.) and E. J. Squires. Nuclear Phys. 19, 280-98(1960) Oct. (3). (In English)

The differential cross section for p-α scattering at 40 and 95 Mev is calculated with simple gaussian internucleon potentials. Effects due to distortion of the α particle and to the antisymmetry of the wave function are included and shown to be essential in fitting the qualitative features of the experimental cross sections. The results suggest a resolution of difficulties which have been encountered in recent attempts to calculate nucleon-nucleus scattering from nucleon-nucleon phase shifts, by means of multiple incoherent scattering effects which occur when center-of-mass motion is treated correctly. (auth)

5656 THE DECAY ENERGY OF Ba^{133}. M. K. Ramaswamy, W. L. Skeel, and P. S. Jastram (Ohio State Univ., Columbus). Nuclear Phys. 19, 299-302(1960) Oct. (3). (In English)

The transition energy for the decay of Ba^{133} to Cs^{133} was determined to be 489 kev, confirming Gupta's results, in disagreement with the estimate of 700 kev from β-decay systematics. The log ft values for the orbital capture transitions to the 437 and 381 kev levels, as well as γ cascade studies reported previously support a single-particle description for all of the low-lying levels of Cs^{133}, with the possible exception of the one at 158 kev. The doublet splitting between the $d_{5/2}$ and $d_{3/2}$ levels is found to be 300 kev. This splitting and the ground-state quadrupole moment are however not in good agreement with estimates based on a pure single-particle configuration. (auth)

5657 COLLECTIVE VIBRATIONS IN P^{31}. V. K. Thankappan and S. P. Pandya (Physical Research Lab., Ahmedabad, India). Nuclear Phys. 19, 303-8(1960) Oct. (3). (In English)

An attempt is made to explain the energy levels and the electromagnetic transitions in P^{31} in terms of the collective vibrational model. The results are found to be fairly satisfactory. (auth)

5658 A REMARK ON THE COULOMB DISINTEGRATION OF ACCELERATED HEAVY IONS. Johannes M. Hansteen (Univ. of Oslo, Blindern, Norway). Nuclear Phys. 19, 309-13(1960) Oct. (3). (In English)

The Coulomb disintegration of heavy ions is treated by a semiclassical perturbation method, considering the repulsion of the bombarding particle in the Coulomb field of the target nucleus. The cross section for the electric break-up of C^{12} nuclei into three α particles in nuclear emulsions is found to be of the order of 10^{-27} cm^2 for projectile energies of approximately 100 Mev. This seems to be in conformity with the very scanty experimental data. (auth)

5659 GAMMA RADIATION FROM EXCITED STATES OF F^{18}, Na^{22}, AND Ne^{22}. T. A. Rabson, T. W. Bonner, R. Castillo-Bahena, M. V. Harlow, Jr., H. P. Haenni, and W. A. Ranken (Rice Inst., Houston, Tex.). Nuclear Phys. 19, 314-26(1960) Oct. (3). (In English)

Gamma radiation from the proton bombardment of O^{18}, the He^3 bombardment of O^{16}, and the α bombardment of F^{19} were studied with a magnetic lens photo conversion spectrometer and a NaI spectrometer. Gamma rays from the bombardment of an O^{18} target with protons were observed with energies 0.511 ± 0.004, 0.666 ± 0.005, 0.938 ± 0.006, 1.043 ± 0.008, 1.082 ± 0.010, and 1.990 ± 0.010 Mev. Gamma rays from the bombardment of an O^{16} target with 2.83 Mev He^3 particles were observed with energies of 0.189 ± 0.005, 0.66 ± 0.02, 0.95 ± 0.02, 1.07 ± 0.02, 1.71 ± 0.03, 2.14 ± 0.03, 2.54 ± 0.03, and 3.11 ± 0.05 Mev. The internal conversion coefficient of the 0.189 Mev radiation was measured to be $(2.86 \pm 0.4) \times 10^{-3}$. The energies of the γ radiation from the α particle bombardment of a F^{19} target were observed to be 0.073 ± 0.002, 0.109 ± 0.002, 0.586 ± 0.004, 0.892 ± 0.005, 1.275 ± 0.008, 1.530 ± 0.010, and 2.090 ± 0.016 Mev. The internal conversion coefficients of the 0.073, 0.109, and 0.586-Mev gammas were observed to be $(4.5 \pm 0.4) \times 10^{-3}$, $(2.8 \pm 0.5) \times 10^{-3}$, and $(1.14 \pm 0.3) \times 10^{-4}$, respectively. (auth)

5660 LOWER EXCITED STATES OF W^{185}. H. Morinaga and K. Nagatani (Tohoku Univ., Sendai). Nuclear Phys. 19, 327-36(1960) Oct. (3). (In English)

The decays of Ta^{185} and W^{185m} were investigated with a scintillation spectrometer with a coincidence circuit. The sources were prepared from photodisintegration of metallic tungsten. Gamma rays observed were essentially the same as previous results by Pöe except for a few new lines. A decay scheme is proposed for both decays. The decay of Ta^{185} is consistently explained with the unified model for strongly deformed nuclei. The isomer is difficult to explain from the unified model. It is suggested that the isomeric state may represent a spherical state. (auth)

5661 THE DECAY OF Ir^{194}. J. Kern and G. Bäckström (Inst. of Physics, Uppsala). Nuclear Phys. 19, 461-81(1960) Nov. (6). (In English)

The decay of Ir^{194} was investigated by means of a double focusing spectrometer, mostly by the photo-electron technique. A total of 32 transitions was observed, and their energies and intensities were measured. An internally converted transition of 1480 kev, for which no γ ray could be detected, showed that a 0+ state of this energy is populated. The log ft values for the β branches showed that all the 18 levels excited are of even parity. By comparison of the measured γ intensities with the conversion intensities of corresponding transitions in the decay of Au^{194}, spin values could be assigned for many levels. Evidence for a new 0+ state at 1547 kev was obtained in this manner. Indications were found for E0 admixture in competition with M1 and E2 multipolarities. A state of 923 kev may be interpreted as the 3+ level in the asymmetric rotor theory. (auth)

5662 PAIRING INTERACTION IN NUCLEI. G. Abraham (Atomic Energy Establishment, Trombay, India), and K. K. Gupta. Nuclear Phys. 19, 496-9(1960) Nov. (6). (In English)

The first excited levels of oxygen, calcium, and lead isotopes were calculated, using a constant pair interaction between particles outside the doubly closed shells. Quantitative agreement with experiment is obtained only for the lead isotopes. (auth)

5663 THE INTERACTION OF 40-160 Mev NEUTRONS WITH HELIUM NUCLEI. M. Arnold (Clarendon Lab., Oxford), P. E. Hodgson, D. F. Shaw, and D. M. Skyrme. Nuclear Phys. 19, 500-10(1960) Nov. (6). (In English)

The collisions of 40–160 Mev neutrons with helium nuclei was observed in a high pressure diffusion cloud chamber in a magnetic field of 12 kG. Results are presented for the angular distribution of elastically scattered neutrons in the energy ranges 40 to 80, 80 to 120, and 120 to 160 Mev. These are analyzed using an optical model of the interaction with the Bjorklund-Fernbach radial variation with potentials adjusted to give the measured absorption and total cross section. The calculated distribution falls below the experimental at backward angles owing to the neglect of exchange reactions by the optical model. Agreement may be obtained by using an abnormally small value of the diffuseness of the nuclear surface. The energy distribution is given for the identified He^3 recoils resulting from neutron stripping. Although it has not been possible to carry out a detailed analysis of the observed inelastic events, it is concluded that the inelastic cross section is approximately constant at about 100 mb over the energy range 80 to 160 Mev. (auth)

5664 GAMMA RAYS FROM THE 351-kev $C^{14}(p,\gamma)$ RESONANCE. D. F. Hebbard (California Inst. of Tech., Pasadena). Nuclear Phys. 19, 511-22(1960) Nov. (6). (In English)

Measurements were made on the energies and the angular distributions of γ rays from the 351-kev resonance in $C^{14}(p,\gamma)$. The observed transitions in N^{15} are the cascades 10.543 → 7.309 → 0 Mev, 10.543 → 5.276 → 0 Mev, and 10.543 → 7.164 → 5.276 → 0 Mev. These transitions are consistent with the decays of the 7.309-Mev and 7.164-Mev levels observed in the $N^{14}(d,p)$ and $N^{14}(n,\gamma)$ reactions. The angular distribution measurements are consistent with a $\frac{5}{2}$ spin assignment for the 10.543-Mev level, and $\frac{3}{2}$ spin assignment for the 7.309-Mev level, a $\frac{5}{2}$ assignment for the 5.276-Mev level, and a $\frac{5}{2}$ assignment (with less certainty) for the 7.164-Mev level. (auth)

5665 INELASTIC SCATTERING FROM EVEN RARE EARTH ISOTOPES. B. Elbek, M. C. Olesen, and O. Skilbreid (Univ. of Copenhagen). Nuclear Phys. 19, 523-34 (1960) Nov. (6). (In English)

The Coulomb excitation cross sections for the first excited state of 15 even-mass nuclei in the region of the rare earths were determined from measurements on inelastically scattered protons and deuterons. From the cross sections, reduced E2-transition probabilities are obtained, which are, in general, in good agreement with those derived from the directly measured lifetimes of the nuclear states. The intrinsic quadrupole moments determined from the transition probabilities show for each element a regular variation with the mass number, but discontinuities occur when passing from one element to another. This behavior appears to be correlated with the variation in the

moment of inertia for the same nuclei. The individual intrinsic quadrupole moments of odd-mass nuclei in the same region often deviate from the moments of the neighboring even isotopes, but on the average the quadrupole moments of odd-mass nuclei are almost the same as those for even nuclei. (auth)

5666 NEUTRON CROSS-SECTIONS IN ALUMINIUM. G. S. Mani, G. J. McCallum, and A. T. G. Ferguson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys. 19, 535-49(1960) Nov. (6). (In English)

The (n,p) and (n,α) cross-sections in aluminum were measured for neutron energies from 12 to 21 Mev; the cross-section for the (n,2n) reaction leading to the 228 kev isomeric state in Al^{26} was determined from the threshold to 21 Mev. The relative cross sections in the above-mentioned neutron energy ranges were determined by measuring the γ ray activity associated with the β decay of the residual nucleus; the absolute cross sections were obtained by normalizing to the values measured by other workers at 14 Mev. These results are compared with the statistical theory of nuclear reactions. (auth)

5667 INVESTIGATIONS OF THE DECAY-SCHEME OF Rh^{101}. B. L. Sharma (Ohio State Univ., Columbus). Nuclear Phys. 19, 550-4(1960) Nov. (6). (In English)

Enriched Ru^{101} bombarded with 6-Mev protons was observed to emit 75, 310, and 545 kev γ rays, each decaying with a 4.4 d half life. However, the lead and copper absorption measurements strongly indicated that the 75 kev photo peak, observed in well crystal measurements, was actually due to the lead K x ray, produced by the photoelectric absorption of the 310 kev γ ray in the lead shield around the crystal. A weak 235 kev γ ray was observed to be in coincidence with the 310 kev γ ray previously assigned to Rh^{101}. The latter was not in coincidence with 545 kev. After the decay of 4.4 d activity, γ rays of 127 and 198 kev were observed to be in coincidence and have a very long half life. The 127 kev γ ray was associated with Rh^{101} from the reported Coulomb excitation of Ru^{101} and the decay of Tc^{101}. The proposed decay scheme, having levels at 127, 310, 325 and 545 kev, is presented. (auth)

5668 TWO-BODY CLUSTER STATES IN NUCLEI. G. C. Phillips and T. A. Tombrello (Rice Inst., Houston, Tex.). Nuclear Phys. 19, 555-78(1960) Nov. (6). (In English)

A number of experimental results from nuclear states are cited that require a description of the nucleus as the interaction of two clusters of nucleons. The types of experiments that yield information about states of two-cluster parentage are considered. The clusters identified and discussed consist of such bodies as deuterons, excited deuterons, α particles, tritons, He^3, and nuclei in an excited state such as $^8Be^8$ and $^8C^{12}$. The general nature of the nuclear forces necessary to produce clustering is discussed, and a phenomenological model describing these cluster states in terms of coupled Schrödinger equations is presented. The model is compared with other current models of nuclear structure. Several definite predictions of the model for the dynamical behavior of nuclear systems are given. (auth)

5669 (α,p) REACTIONS IN MEDIUM WEIGHT ELEMENTS. N. O. Lassen and V. A. Sidorov (Univ. of Copenhagen). Nuclear Phys. 19, 579-88(1960) Nov. (6). (In English)

Thin targets of V^{51}, Co^{59}, Ni^{58}, Ni^{60}, Cu^{63}, and Cu^{65} were bombarded with α particles of laboratory energies of 19.3, 17.8, 16.3, and 11.9 Mev. The spectra of emitted protons at 45, 90, and 135° were measured by means of an ionization chamber. Two groups of protons were seen. One group contains almost exclusively protons boiled off from the compound nucleus and only a very small number of protons created in direct interactions. The other group with energies below the Coulomb barrier contains protons emitted from daughters of the compound nucleus, i.e., secondary protons from (α,np), (α,2p), and (α,αp) reactions. Both groups show symmetry around 90°. The first group is only slightly anisotropic, whereas the second group exhibits a considerably higher anisotropy, indicating higher angular momenta for the secondary emitted protons. Using the formula from the statistical theory, the variation of the level density ρ with the excitation energy E^* was deduced from the spectral shape of the first group of protons. For the range of excitation energies 6 to 10 Mev, the spectra are consistent with a constant temperature of the order of one Mev. However, the values obtained for the temperature increase with increasing energy of the bombarding α particles. (auth)

5670 ANGULAR DISTRIBUTIONS IN PHOTOFISSION OF URANIUM. Bengt Forkman and Sven A. E. Johansson (Univ. of Lund, Sweden). Nuclear Phys. 20, 136-54(1960) Oct. (4). (In English)

The angular distributions in photofission of natural uranium were measured. Bremsstrahlung with maximum energies of 10 and 20 Mev and monoenergetic γ radiation of 6.1-, 6.9-, and 7.1-Mev energy were used as photon sources. The fission fragments were detected in two ways. One method was to irradiate nuclear emulsions containing uranium. In the other method a scintillation counter was used to detect the fission fragments. The first method was more tedious but had a considerably better angular resolution. The two methods give results which agree very well. The following results were obtained: The angular distribution at 6.1 Mev was of the form $0.07 + \sin^2\theta + 0.37 \sin^2 2\theta$. At 6.9 Mev the distribution $1 + 0.70 \sin^2\theta + 0.05 \sin^2 2\theta$ was obtained. The distribution at 7.1 Mev was similar but somewhat more isotropic. The angular distribution obtained by 10-Mev bremsstrahlung was of the form $1 + 0.85 \sin^2\theta + 0.13 \sin^2 2\theta$. Irradiation with 20-Mev bremsstrahlung gave an isotropic angular distribution. The results of the present work are compared with the theory of A. Bohr. They agree very well with this theory. It is also possible to use these results to separate the photonuclear absorption at 6 Mev into a dipole and a quadrupole part. The quadrupole absorption in particular is discussed and compared with theoretical estimates. (auth)

5671 BALANCED ION CHAMBER MEASUREMENT OF HALF-LIVES OF SEVERAL RADIOISOTOPES. H. T. Easterday and R. L. Smith (Univ. of Oregon, Eugene). Nuclear Phys. 20, 155-8(1960) Oct. (4). (In English)

Half lives of six γ emitters were measured using a Balanced Ion Chamber arrangement with one chamber driven by a radium source. Data analyzed by least squares yielded the following results: Se^{75}, 120.4 ± 0.2 day; Zn^{65}, 245.7 ± 1.1 day; Ru^{106}, 265.8 ± 1.7 day; Ag^{110m}, 255.0 ± 0.8 day; Cs^{134}, 2.05 ± 0.05 year, and Ce^{144}, 277 ± 4 day. (auth)

5672 ANGULAR CORRELATION MEASUREMENTS IN Ba^{136}. Z. Grabowski (Inst. of Physics, Uppsala), S. Gustafsson, I. Marklund, and I. B. Hiller. Nuclear Phys. 20, 159-68(1960) Oct. (4). (In English)

The angular correlation of cascading transitions between levels in Ba^{136} excited from Cs^{136} was investigated with an automatic γ-γ directional correlation apparatus and with an electron-γ correlation apparatus. The measured cascades

are (kev): 1065 to 830, 1255 to 830, 337 to 1065, and 270 to 1065. They give the following spins of energy levels in Ba^{136} (kev (I, π)): 0(0+), 830(2+), 1900(4+), 2090(4+), 2170(5+), and 2240(6+). (auth)

5673 THE BETA DECAY OF NEODYMIUM-147. Hans-Dietrich Wendt and Peter Kleinheinz (Physikalisches Staatsinstitut, Hamburg). Nuclear Phys. 20, 169-82(1960) Oct. (4). (In German)

The β decay of Nd^{147} was investigated using a double-lens spectrometer and fast-slow $\beta-\gamma$ coincidence technique. A total of five β-transitions, including one not previously reported was found. Their end-point energies, partial intensities, and log ft values are: 809 kev (64.7%), log ft = 7.6; 719 kev (10.4%), log ft = 8.1; 480 kev (0.5%), log ft = 9.0; 370 kev (12.1%), log ft = 7.3, and 215 kev (12.3%), log ft = 6.5. A level scheme in agreement with the observed data is proposed and spins are discussed for the daughter nucleus Pm^{147}. (auth)

5674 THERMAL NEUTRON CROSS SECTIONS FOR PRODUCING ISOMERS (II). H. S. Hans, M. L. Sehgal, and P. S. Gill (Muslim Univ., Aligarh, India). Nuclear Phys. 20, 183-7(1960) Oct. (4). (In English)

Thermal neutron cross sections for the production of isomers were measured for the following cases by making irradiations with the swimming pool reactor at Trombay, Bombay: $Se^{78}(n,\gamma)Se^{79m}$, $Sr^{84}(n,\gamma)Sr^{85m}$, $Sr^{84}(n,\gamma)Sr^{85}$, $Rb^{85}(n,\gamma)Rb^{86m}$, $Ba^{132}(n,\gamma)Ba^{133m}$, $Ba^{134}(n,\gamma)Ba^{135m}$, $Ba^{136}(n,\gamma)Ba^{137m}$, $Os^{190}(n,\gamma)Os^{191,191m}$, and some others. Activation method was employed using scintillation technique. Isomeric ratios seem to follow the rule of Mateosian and Goldhaber. (auth)

5675 EFFECT OF FINITE LIFE OF UPPER LEVEL ON PROBABILITY OF COULOMB EXCITATION. G. Breit and R. L. Gluckstern (Yale Univ., New Haven). Nuclear Phys. 20, 188-201(1960) Oct. (4). (In English)

The effect of the finite life of the upper level on the probability of Coulomb excitation was calculated in the semiclassical approximation. The problem was first treated by considering the upper level to be coupled to the continuum by means of a matrix element as in the Weisskopf-Wigner treatment of emission and absorption in radiation theory. Equations for the excitation probability at intermediate times were worked out. The over-all transition probability from the ground state to the continuum was transformed in terms of an integral over energies for a transition to a level with infinite lifetime. The result was then interpreted and generalized in terms of direct transitions to the continuum of stationary states without making use of the division of the nuclear hamiltonian into parts which provided the matrix element of the first treatment. The second approximation provided a more accurate formula for the over-all transition probability and relates the Coulomb excitation probability directly to the Einstein absorption probabilities per unit frequency range. A schematic illustration is given for the increase in the number of transitions from the ground state. (auth)

5676 ABSOLUTE NEUTRON ABSORPTION CROSS SECTIONS FOR Sb–Be PHOTONEUTRONS. H. W. Schmitt (Oak Ridge National Lab., Tenn.) and C. W. Cook. Nuclear Phys. 20, 202-19(1960) Oct. (4). (In English)

Absolute absorption cross sections of Cu, Zn, Ag, Cd, In, Sb, I, Au, Hg, and Pb were measured for Sb-Be photoneutrons the average energy of which is given as 24.0 ± 2.2 kev. A specially designed antimony-beryllium neutron source was used in spherical shell transmission measurements. A detailed account of the method, including discussion of the experimental measurements and analysis of data, is given. Absorption cross sections obtained are as follows: Cu, 42 ± 15 mb; Zn, 64 ± 20 mb; Ag, 1185 ± 80 mb; Cd, 515 ± 70 mb; In, 823 ± 60 mb; Sb, 565 ± 45 mb; I, 885 ± 90 mb; Au, 585 ± 60 mb; Hg, 380 ± 100 mb; and Pb, 3 ± 9 mb. (auth)

5677 A SYSTEMATIC INVESTIGATION OF π^--MESONIC DECAYING HYPERFRAGMENTS PRODUCED BY K^- MESONS. J. Tietge (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Phys. 20, 227-53(1960) Oct. (4). (In German)

A stack of nuclear emulsions (Ilford G5), exposed to the 300-Mev/c K^- beam of the Berkeley Bevatron was scanned systematically for hyperfragments. Thirty-six hyperfragments decaying by the π^--mesonic mode were found. Twenty-four of these hyperfragments could be analyzed uniquely in the sense of the criteria given. Binding energies were obtained for ${}_\Lambda H^3$, ${}_\Lambda H^4$, ${}_\Lambda He^4$, ${}_\Lambda He^5$, ${}_\Lambda Li^8$, and ${}_\Lambda Li^9$. Angular, energy, and momentum distributions of the ${}_\Lambda He^5$ decay products were studied and compared with the corresponding theoretical distributions given by Byers and Cottingham. The mean lifetime for ${}_\Lambda H^4$ hyperfragments was calculated. Finally, the nuclear capture of a Σ^- hyperon is described, from which a hydrogen nucleus (very probably a proton) and a π^- meson were emitted. (auth)

5678 TERTIARY AND GENERAL-ORDER COLLISIONS. [PART] II. L. M. Delves (Massachusetts Inst. of Tech., Cambridge). Nuclear Phys. 20, 275-308(1960) Oct. (4). (In English)

The basis introduced in a previous paper for describing collisions involving more than two free particles in ingoing or outgoing channels is discussed in more detail. With this formalism, channel wave functions for many-particle channels are formally identical to the usual two-particle wave functions and require no special treatment. The scattering matrix referring to open channels is unitary and symmetric when many-particle channels are included; its symmetries in the complex k-plane are also discussed. Long-range effects in many-particle channels are considered, and it is shown that these can modify the threshold behavior of matrix elements given previously. Effective range expansions, valid for many-particle channels, are given for the reactance matrix and eigen phase shifts. (auth)

5679 A STUDY OF THE ANGULAR DISTRIBUTIONS OF NEUTRONS LEADING TO THE GROUND STATE IN THE REACTION $^{12}C(^3He,n)^{14}O$. N. H. Gale, J. B. Garg, J. M. Calvert, and K. Ramavataram (University, Manchester, Eng.). Nuclear Phys. 20, 313-20(1960) Oct. (4). (In English)

A pulsed beam time-of-flight neutron spectrometer was used to study the neutrons emitted from a target of C^{12} bombarded with singly ionized He^3 particles having energies of 4.09, 4.62, 5.16, and 5.70 Mev. The angular distributions of the neutron group leading to the ground state of O^{14} were compared with a double stripping theory, and good agreement was obtained with the theoretical prediction for transfer of zero orbital angular momentum. It is emphasized that the angular distributions alone are insufficient to distinguish between a stripping process or a direct knock-out mechanism, but arguments are advanced which favor the former. On the assumption that the mechanism of the reaction is that of double-stripping, the results led to the assignment of a spin zero and even parity to the O^{14} ground state. (auth)

5680 A NEW ISOMERIC STATE OF Cs^{131}. E. Bodenstedt, H. J. Körner, C. Günter, D. Hovestadt, and J. Radel-

off, II (Universität, Hamburg). Nuclear Phys. 20, 557-60 (1960) Nov. (3). (In English)

A new isomeric state of Cs^{131} at 133 kev was found. The half life was determined as $T_{1/2} = 13.3 \pm 0.5$ ns. The level is interpreted as the $g_{7/2}$ shell model state. A new determination of the half life of the 124 kev level gave $T_{1/2} = 3.77 \pm 0.05$ ns. (auth)

5681 EXCEPTIONS TO GAMMA INTENSITY RULES IN NUCLEAR ROTATIONAL SPECTRA. K. Helmers (Physikalisches Staatsinstitut, Hamburg). Nuclear Phys. 20, 585-9(1960) Nov. (3). (In English)

The usual γ intensity rules in nuclear rotational spectra can be proved only for transition operators that do not depend on collective angular momentum. It is shown that in the Bohr-Mottelson nuclear model only the magnetic dipole and magnetic octupole operators do not satisfy this condition and thus may give rise to unusual branching ratios. (auth)

5682 CLASSICAL TREATMENT OF NUCLEAR REACTIONS INDUCED BY FAST NUCLEONS. Ken Kikuchi (Univ. of Minnesota, Minneapolis). Nuclear Phys. 20, 590-600(1960) Nov. (3). (In English)

The direct process in nuclear reactions was studied using a simplified classical model. The process of the usual inelastic scattering type is found to give a contribution of 10 to 25% to the total cross section. The more complicated processes, in which two or more collisions take place, seem to contribute 10% to the absorption cross section. (auth)

5683 EXCITATION OF HEAVY NUCLEI BY FAST NUCLEONS. Ken Kikuchi (Univ. of Minnesota, Minneapolis). Nuclear Phys. 20, 601-13(1960) Nov. (3). (In English)

Nuclear reactions induced by fast nucleons are studied on the basis of a classical model. A formula is obtained to calculate the energy spectrum of all nucleons emitted, taking account of the successive collisions between the incident nucleon and the nucleons in the target nucleus. The result is compared with the energy spectrum predicted by the statistical theory. Calculated energy spectra and cross sections are found to be in fair agreement with the experimental results. (auth)

5684 THE ELECTRON SPECTRUM OF $_{81}Tl^{199}$. B. Jung and J. Svedberg (Univ. of Uppsala). Nuclear Phys. 20, 630-47(1960) Nov. (3). (In English)

The electron spectrum between 5.75 and 950 kev of mass separated Tl^{199} sources was studied in a double focusing β-spectrometer, adjusted to a momentum resolution of about 0.4%. The experimental findings are in accordance with the following level sequence in Hg^{199}: ground state ($^1/_2-$), 158.4 ($^5/_2-$), 208.2 ($^3/_2-$), 403.4 ($^1/_2-$), 455.4 ($^1/_2-$), and 492.2 kev ($^3/_2-$). The half-life of Tl^{199} was measured as 7.42 ± 0.08 h. The K- and L-Auger spectra of mercury are briefly discussed. (auth)

5685 A TWO-BODY CLUSTER MODEL OF THE NUCLEUS. T. A. Tombrello and G. C. Phillips (Rice Inst., Houston, Tex.). Nuclear Phys. 20, 648-62(1960) Nov. (3). (In English)

Calculations are presented for coupled Schrödinger equations which develop the detailed behavior predicted by the two-body cluster model described previously. The results show that narrow resonances in the scattering cross section may be quantitatively described by this model, the cross section in the neighborhood of the threshold of another channel shows the Wigner cusp, and the configuration mixing of bound states is a necessary consequence of the model. As an example, the model is used as a means of parameterizing the lowest $J = ^5/_2{}^+$ states in C^{13}. This method allows a fit to the scattering phase shift and the level structure, at the same time making a definite prediction of the fractional parentage of the $^5/_2{}^+$ bound state. (auth)

5686 CLASSIFICATION OF ALPHA PARTICLE WAVE FUNCTIONS. L. Cohen (Univ. of Southampton, Eng.). Nuclear Phys. 20, 690-7(1960) Nov. (3). (In English)

A classification is given of the functions that can occur in the α particle ground state wave function. Isobaric spin functions, spin and orbital angular momentum functions, and internal functions are classified according to their behavior under the permutation group of four particles and combined to form completely antisymmetric functions. Three S-state functions, eight P-state functions, and six D-state functions are obtained. (auth)

5687 THE ANGULAR DISTRIBUTIONS OF THE GAMMA RADIATION FROM THE $Li^7(p,\gamma)Be^8$ REACTION FROM $E_p = 200$ kev TO 1100 kev. B. Mainsbridge (Australian National Univ., Canberra). Nuclear Phys. 21, 1-14 (1960) Nov. (4). (In English)

Angular distributions of the γ radiation from the $Li^7(p,\gamma)Be^8$ reaction were measured as a function of proton energy from $E_p = 200$ kev to 1100 kev with targets 5 to 20 kev thick. Separation of the γ rays corresponding to transitions to the ground state and first excited state of Be^8 shows the respective angular distributions to differ markedly in the neighborhood of the 441 and 1030 kev resonances as a result of the interference between the resonant, even parity states, and proton interactions of opposite parity. The angular distributions of the resonant γ rays are isotropic at $E_p = 441$ kev and are consistent with the resonance being p-wave ($J = 1^+$) with channel spins 1 and 2 in the ratio of $^1/_5$; they do not lead to definite conclusions on the mechanism of the 1030 kev resonance but are not inconsistent with the resonance being p-wave ($J = 1^+$) with channel spins 1 and 2 in the ratio $^1/_5$, the resonance radiation being isotropic but mixed with a d- and s-wave contribution in the nonresonant background. A $\cos^2\theta$ term in the angular distributions above $E_p = 460$ kev, which rises steadily with proton energy, has been attributed to d-wave proton interaction in the background. (auth)

5688 THE ELASTIC SCATTERING OF 96 Mev NEUTRONS BY NUCLEI. G. L. Salmon (Clarendon Lab., Oxford). Nuclear Phys. 21, 15-20(1960) Nov. (4). (In English)

The differential cross sections for the elastic scattering of neutrons of mean energy 96 Mev were measured out to the first diffraction minimum for Li, Be, C, Al, Cu, Cd, Pb, and U. (auth)

5689 THE ELASTIC SCATTERING OF HELIUM 3 BY MEDIUM WEIGHT NUCLEI. P. E. Hodgson (Clarendon Lab., Oxford). Nuclear Phys. 21, 28-32(1960) Nov. (4). (In English)

The experimental results of Greenlees and Rowe on the elastic scattering of He^3 by Ni, Pa, Cd, and Sn are analyzed by the optical model. The scattering cross-section is found to be more sensitive to the diffuseness of the nuclear surface than to the other parameters of the nuclear potential. The values found for the Saxon-Woods diffuseness factor a are: Ni, 0.61 ± 0.02; Pa, 0.61 ± 0.02; Cd, 0.52 ± 0.03; and Sn, 0.50 ± 0.02 ($\times 10^{-13}$ cm). (auth)

5690 ANGULAR CORRELATION IN $C^{12}(n,n'\gamma)C^{12}$ AT 14 Mev. G. Deconninck and A. Martegani (Centre de Physique Nucléaire, Louvain, Belg.). Nuclear Phys. 21, 33-7(1960) Nov. (4). (In English)

A method is developed for measuring angular correlation in inelastic scattering of 14 Mev neutrons. Random coincidences are practically suppressed by combining time of flight and fast coincidences techniques. Angular correlation has been measured on the first excited state of C^{12}, and the results are in good agreement with Banarjee and Levinson's calculations based on the distorted wave method. (auth)

5691 ELASTIC SCATTERING OF 13 Mev DEUTERONS ON ALUMINUM. N. Cindro, M. Cerineo (Ruder Bošković Inst., Zagreb) and A. Strzalkowski. Nuclear Phys. 21, 38-42(1960) Nov. (4). (In English)

The angular distribution of 13 Mev deuterons scattered elastically on aluminum was measured by means of the thin scintillation crystal technique. Although not so prominent as at 15 Mev, the increase of the differential cross section at backward angles was also observed at the deuteron energy of 13 Mev. The reason for back angles maxima in elastic scattering has not been elucidated so far. (auth)

5692 GAMMA RADIATIONS FROM EXCITED STATES OF Ne^{20}. T. A. Rabson, W. D. Barfield, D. L. Bernard, T. W. Bonner, and W. W. Givens (Rice Univ., Houston, Tex.). Nuclear Phys. 21, 43-8(1960) Nov. (4). (In English)

Gamma radiations from excited states of Ne^{20} were measured with a lens type pair spectrometer. The nuclear reactions used are $F^{19}(d,n)Ne^{20}$ and $Na^{23}(p,\alpha)Ne^{20}$. Gamma radiation with Doppler corrected energies of 7.26, 8.26, 9.22, 9.98, 10.59, and 11.31 Mev was attributed to Ne^{20}. The 8.26 Mev and 10.59 Mev γ rays are believed to be due to cascades, 9.98 → 1.63 and 12.22 → 1.63, and the remainder are due to ground state transitions. Gamma radiation was also observed with an energy of 6.67 Mev, which is attributed to F^{20}, and a γ ray with an energy of 6.17 Mev was observed and attributed to O^{16}. A search was made for nuclear pairs from a 0^+ excited state of Ne^{20} at 4.25 or 4.97 Mev, using the $Na^{23}(p,\alpha)Ne^{20}$ reaction. No nuclear pairs were observed which indicates that the 4.25 Mev state is not 0^+. (auth)

5693 STRIPPING ANALYSIS OF THE REACTION $Na^{23}(d,p)Na^{24}$. F. A. El Bedewi (Atomic Energy Establishment, Cairo) and M. A. El Wahab. Nuclear Phys. 21, 49-54(1960) Nov. (4). (In English)

A heavy particle magnetic spectrograph was used to study the energies and angular distributions of proton groups emitted from a sodium target bombarded with 8.60 Mev deuterons. New excited states in Na^{24} were observed at 4.74 ± 0.04 Mev and 5.13 ± 0.08 Mev. The angular distributions of some proton groups were compared with curves calculated from deuteron stripping theories. While an s- or d-wave neutron capture is observed for the low lying levels, a p-wave is found to dominate the higher excited states. (auth)

5694 CONTRIBUTIONS TO THE DECAY OF Eu^{152}. Werner Schneider (Swiss Federal Inst. of Tech., Zurich). Nuclear Phys. 21, 55-65(1960) Nov. (4). (In English)

The spectrum of the $\beta-$ particles emitted in the decay of 13 y Eu^{152} was studied with a magnetic spectrometer of the Zünti-type and with a semicircular spectrometer of high resolution. The shape factor proposed by Langer et al. for the 1490 kev $\beta-$ spectrum was confirmed, and the relative intensities of the other $\beta-$ transitions were redetermined. Only the intensity of the 1070 kev $\beta-$ transition is strongly influenced by the choice of the correction factor applied to the spectrum of the 1490 kev $\beta-$ transition. The energies and intensities of internal conversion lines obtained in this experiment are in good agreement with those previously reported. The spin-parity assignment for the highest excited level in Gd^{152} is proposed to be $2-$. (auth)

5695 PARAMETERS AND GAMMA-RAY SPECTRA OF NEUTRON RESONANCES IN THE ISOTOPES OF MERCURY. R. T. Carpenter and L. M. Bollinger (Argonne National Lab., Ill.). Nuclear Phys. 21, 66-98(1960) Nov. (4). (In English)

The Argonne fast chopper was used to study the neutron resonances of mercury. The neutron transmissions of five samples of normal mercury and six isotopically enriched samples were measured in the energy interval from 10 to 30,000 ev. Twenty-eight resonances were isotopically identified and parameters, including the spin, were determined for most of them. Average values of level spacings, radiation widths, and neutron strength functions were derived from the individual parameters. The spacings and radiation widths exhibit the expected rapid increase as the doubly closed shell is approached. Unexpectedly the total radiation widths of different resonances of Hg^{201} are found to fluctuate by a larger factor than has been previously observed in any other nuclear species. The γ ray spectra and the multiplicity of γ rays from capture in these resonances were measured and both quantities were found to differ from resonance to resonance in a way that is consistent with the fluctuations in the widths. Seven high-energy γ rays were resolved in the capture γ-ray spectra of three resonances in Hg^{201}. The absolute intensities of the transitions were determined by a least-squares fit of the data to an experimentally determined line shape. It was found that these high-energy transitions are on the average enhanced, relative to those of lower energy, by about a factor of 15 beyond the usual $E\gamma^3$ law. The remainders obtained by subtracting the partial widths of the seven high-energy transitions from the total radiation widths are constant, within errors, for the three resonances investigated; this indicates that the fluctuations in the total radiation width are the result of fluctuations in the intensities of the transitions of highest energy. The observed magnitude of the fluctuations is shown to be consistent with that expected from random fluctuations of the partial radiation widths. (auth)

5696 ALUMINUM (p,γ) RESONANCES WITH H_1^+, H_2^+ AND H_3^+ IONS. P. F. Dahl, D. G. Costello, and W. L. Walters (Univ. of Wisconsin, Madison). Nuclear Phys. 21, 106-15(1960) Nov. (4). (In English)

Aluminum (p,γ) resonances were studied with H_1^+, H_2^+, and H_3^+ ions, under a variety of conditions, to clarify discrepancies between molecular ion results and results with H_1^+ ions. Thick target γ-ray yield curves from H_2^+ ions are very asymmetric. They are accurately fitted by assuming the electron in the ion is torn away the moment the target is struck. The ensuing Coulomb force pushes the two protons apart. Proton energies in the laboratory system are substantially changed, and some protons pass through the resonance twice. Six resonance energies were measured with protons in terms of the Li(p,n) threshold at 1881.1 kev. Values obtained are (in kev) 632.8 ± 0.2, 923.4 ± 0.3, 937.7 ± 0.3, 992.4 ± 0.3, 1001.7 ± 1.0, and 1213.6 ± 0.5. (auth)

5697 NEW NUCLEIDE ACTINIUM-231. K. Takahashi and H. Morinaga (Tokyo Univ.). Nuclear Phys. 21, 133-6 (1960) Nov. (4). (In English)

A new nuclide Ac^{231}, was identified from the reaction of $Th^{232}(\gamma,p)Ac^{231}$ induced by the 25-Mev bremsstrahlung. The activity was chemically separated from fission products with the aid of a recoil method. The half life of this new

isotope was found to be $T_{1/2}$ = 15 ± 1 min and the end-point energy of the β ray was E_β = 2.1 ± 0.1 Mev. Several weak γ rays were also observed. (auth)

5698 NOTE ON COLLECTIVE INTERPRETATION OF THE TWO FIRST 2+ LEVELS OF EVEN NUCLEI. Maurice Jean (Faculté des Sciences, Orsay, France). Nuclear Phys. 21, 142-56(1960) Nov. (4). (In French)

It is shown that the qualitative agreement with the experimentally observed ratio of electromagnetic deexcitation probabilities of the first 2+ levels of even nuclei, which is exhibited by the theoretical predictions of the Davydov and Filippov asymmetric rotor model, can equally well be obtained for a more conventional model effecting a gradual transition between the quadrupole oscillations of spherical nuclei and the vibrations and rotations of spheroidal ones. (auth)

5699 THE DECAY CHAIN $Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$. A. Abdurazakov, K. Gromov, B. Dalkhsuren, B. Dželepov, I. Levenberg, A. Murin, Yu. Norseyev, V. Pokrovskiĭ (Pokrovsky), V. Chumin, and I. Yutlandov (Joint Inst. for Nuclear Research, Dubna, USSR). Nuclear Phys. 21, 164-9(1960) Nov. (4). (In English)

It was established that among the spallation products of tantalum there is an isotope Yb^{164}($T_{1/2}$ = 75 ± 2 min), which disintegrates into a hitherto unknown isotope Tm^{164} ($T_{1/2}$ = 2 ± 0.5 min). Tm^{164} turns into a stable Er^{164}, emitting positons with an end-point energy of 2940 ± 20 kev and 91.5 ± 0.1 kev and 211 ± 2 kev γ rays. (auth)

5700 REACTOR NEUTRON ACTIVATION CROSS SECTIONS FOR A NUMBER OF ELEMENTS. W. S. Lyon (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 8, 378-80(1960) Nov.

Experimentally determined reactor neutron activation cross sections found by use of the ORNL Graphite Reactor are listed. The general method of measurement is described. (auth)

5701 MEASUREMENTS OF Pu AND U^{235} FISSION RATES IN WATER–URANIUM REACTOR SPECTRA. D. Klein (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng. 8, 405-9(1960) Nov.

Measurements of Pu^{239} and Pu^{241} fission rates relative to U^{235} were made in 1.3% enriched uranium metal fueled lattices. Results were obtained in lattices having 0.387-in. diameter rods and water-to-uranium ratios of 2.35:1 or 1:1. The measurements are compared with a calculational model and the agreement is considered good. (auth)

5702 AN EXPERIMENTAL STUDY OF THE RELATIVE U^{235} FISSION ACTIVATION AS A FUNCTION OF ENERGY IN SLIGHTLY ENRICHED URANIUM–WATER LATTICES. John J. Volpe and D. Klein (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng. 8, 416-25(1960) Nov.

Measurements of the relative U^{235} fission rates as a function of energy were made for the TRX facility, a slightly enriched uranium, light water moderated critical assembly. The parameter directly measured is the ratio of the activity of a bare U^{235} foil to that of a similar foil enclosed in a box of absorbing material, which was either cadmium, boron, or gadolinium. The energy dependence associated with these ratios was obtained by the introduction of "effective cutoff energies" for the absorbing shields. A comparison is made with calculated values, based upon a simplified model for the neutron energy spectrum present, and the agreement is considered adequate. (auth)

5703 AN EXAMPLE OF THE REACTION: $K^- + {}^{12}C \rightarrow {}^{9}Be_\Lambda + \pi^- + {}^{3}He$ AND THE SUBSEQUENT DECAY IN FLIGHT OF THE ^{9}Be HYPERFRAGMENT. M. Taher-Zadeh (Univ. of California, Los Angeles). Nuovo cimento (10) 17, 980-2(1960) Sept. 16. (In English)

An event with all the products from a K^- capture star visible was examined in an emulsion stack exposed in a strong pulsed magnetic field to the separated K^- meson beam of the Bevatron. A drawing of the event is presented together with the energy and penetration data and the reasons for selecting the reaction, which is believed to be $K^- + C^{12} \rightarrow Be^9_\Lambda + \pi^- + He^3$, followed by the decay in flight $Be^9_\Lambda \rightarrow p + \pi^- + Be^8$ and $Be^8 \rightarrow 2\alpha$. The binding energy of the Λ_0 hyperon for this reaction is 6.22 ± 0.44 Mev, which is in good agreement with the known binding energy of Be^9 decay, 6.6 ± 0.31 Mev. Also, the momentum can be balanced in all directions if the decay occurs in flight. (D.L.C.)

5704 (d,t) REACTIONS ON NUCLEI WITH A ≈ 60. B. Zeidman, J. L. Yntema, and B. J. Raz (Argonne National Lab., Ill.). Phys. Rev. 120, 1723-30(1960) Dec. 1.

Energy spectra of tritons from the (d,t) reactions on a number of nuclei with masses between A = 51 and A = 68 were obtained at a deuteron energy of 21.5 Mev. The experiment was performed in the 60-in. scattering chamber, a double NaI crystal system being used for particle identification. The absolute differential cross sections were obtained at 27° (lab) and angular distributions of various triton groups were taken over a range of angles from 7 to 70°. The angular distributions exhibited an oscillatory behavior and were fitted with the Butler theory for neutron pickup. The angular distributions observed in the (d,t) reactions on V^{51} and Cr^{52} corresponded to l = 3 transitions, while in the case of the other nuclei studied (Mn^{55}, Fe^{56}, Fe^{57}, Co^{59}, Cu^{63}, Cu^{65}, Zn^{64}, Zn^{66}, Zn^{67}, and Zn^{68}) both l = 1 and l = 3 transitions were observed. Evidence for the mixing of shell-model configurations is presented. The Butler formalism and empirically determined constants were used to extract reduced widths. (auth)

5705 ANALYSIS OF THE STRUCTURE OF NUCLEI FROM (d,t) REACTIONS. B. J. Raz (Argonne National Lab., Ill. and State Univ. of New York, Oyster Bay), B. Zeidman, and J. L. Yntema. Phys. Rev. 120, 1730-7 (1960) Dec. 1.

The use of experimentally determined reduced widths from (d,t) reactions in analyzing the structure of the ground state of the target nuclei is illustrated. The (d,t) reaction is an especially sensitive and almost unique experimental technique for measuring small components of nuclear wave functions. In this role it becomes a valuable tool in investigating the presence of strong pairing forces in nuclei. This analysis demonstrates the strong mixture of the $2p_{1/2}$ and $1f_{1/2}$ neutron states in the region around A = 60. In contrast to this, nuclei with 28 neutrons show no observable mixing of states. Special attention is given to Fe^{57} and a shell-model wave function is derived that gives the observed magnetic moment as well as the observed (d,t) reduced widths. In this connection a simple general formula is presented for the magnetic moment of any shell-model wave function. (auth)

5706 EXCITATION FUNCTION OF THE REACTION $Be^9(Li^7,Li^8)Be^8$. Robert J. Gerbracht and Byron L. Youtz (Reed Coll., Portland, Oreg.). Phys. Rev. 120, 1738-9 (1960) Dec. 1.

The cross section and thick-target yield as a function of energy were derived for the reaction $Be^9(Li^7,Li^8)Be^8$ over

the laboratory energy range 1.1 to 4.0 Mev. A model was assumed in which the Li^7 picks up the final, loosely-bound neutron of Be^9 only at radial positions considerably outside the nuclear surface, direct reactions being prevented by the Coulomb repulsion. (auth)

5707 REDETERMINATION OF (p,γ) RESONANT ENERGIES USED AS FIXED POINTS ON THE HIGH-ENERGY SCALE. S. E. Hunt, R. A. Pope, D. V. Freck, and W. W. Evans (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Phys. Rev. 120, 1740-4(1960) Dec. 1.

To clear up a discrepancy in the existing absolute measurements of (p,γ) resonances, the proton energies at which strong fluorine and aluminum (p,γ) resonances occur were measured using a 36-in. radius absolute electrostatic analyzer and compared with previous measurements for the lowest energy fluorine resonance using a 12-in. absolute electrostatic analyzer. An accuracy of one part in a thousand is claimed for both instruments and the disagreement was found to be less than 1.5 parts in a thousand. Weighted mean values of fluorine resonances, based on two analyzers, were found to be 340.7 ± 0.3, 484.3 ± 0.3, 873.5 ± 0.7, 1347.7 ± 1.0, and 1373.7 ± 0.8 kev. These are compared with the values obtained by other workers in this field, and found to be in good agreement with those of Herb et al. and Bondelid et al. but discrepancies exist between the present measurements and those of Bumiller et al. (auth)

5708 BETA-GAMMA DIRECTIONAL CORRELATION IN Rb^{86} AND Eu^{152}. Helmut J. Fischbeck and Roger G. Wilkinson (Indiana Univ., Bloomington). Phys. Rev. 120, 1762-7(1960) Dec. 1.

Measurements are reported on the energy dependence of the β-γ angular correlation coefficient in the special first forbidden cases of Rb^{86} and Eu^{152}. Energy selection of the β rays was accomplished with a magnetic β-ray spectrometer having good transmission. It is shown that Rb^{86} cannot be analyzed in terms of the so-called modified B_{ij} approximation. The Eu^{152} decay, on the other hand, can be treated quite satisfactorily in this approximation. It was concluded in this case that a strong selection-rule effect is operative to suppress certain of the matrix elements relative to B_{ij}. The nuclear parameter Y (Kotani's notation) was found to be 0.69 ± 0.06. This agrees well with the value which results from the measured spectrum shape factor. (auth)

5709 FISSION OF Au^{197} AND Bi^{209} BY C^{12} AND O^{16} PROJECTILES. Harold C. Britt and Arthur R. Quinton (Yale Univ., New Haven). Phys. Rev. 120, 1768-77(1960) Dec. 1.

Using a proportional counter, measurements were made of the fission fragment angular distributions, kinetic energy spectra, and the total fission cross sections for the reactions C + Au, O + Au, C + Bi, and O + Bi at 10.5 Mev per nucleon bombarding energies and for the C + Bi reaction at energies from 72 to 126 Mev. The results showed the kinetic energy spectra to be independent of the excitation of the compound system and the most probable fragment kinetic energies to be 75 ± 3 and 81 ± 3 Mev for the gold and bismuth target reactions, respectively. In all cases the fission cross sections were found to be only 60 to 80% of the estimated compound-nucleus formation cross sections. The angular distributions were fitted by the theory of Halpern and Strutinski, and an attempt was made to determine some of the qualitative features of these heavy-ion reactions. (auth)

5710 GROUND STATES OF ODD-ODD NUCLEI. A. de-Shalit and J. D. Walecka (Stanford Univ., Calif.). Phys. Rev. 120, 1790-2(1960) Dec. 1.

The spectrum of odd-odd nuclei was investigated with a general interaction of the type $V_0 + \sigma_1 \cdot \sigma_2 V_1$. It was shown that an inspection of the properties of some Racah coefficients is enough to determine the ground-state spin for particle-particle or hole-hole configurations in most cases. The results agreed qualitatively with empirical evidence summarized by Brennan and Bernstein if V_0 and V_1 are both attractive; this agreement is insensitive to the range and other details of either V_0 or V_1. (auth)

5711 COULOMB EXCITATION OF STATES IN Th^{232} AND U^{238}. F. K. McGowan and P. H. Stelson (Oak Ridge National Lab., Tenn.). Phys. Rev. 120, 1803-11(1960) Dec. 1.

The yield of γ rays resulting from Coulomb excitation of states in Th^{232} and U^{238} with protons of 4- to 6-Mev energy was measured. Gamma rays of 790-, 740-, and 613-kev energy from Th^{232} and of 1.02-Mev energy from U^{238} were observed. For Th^{232}, the variation in γ-ray yields with proton energy, the results from γ-ray angular distributions, and the linear polarization measurements were consistent with the direct excitation of a 2+ state at 790-kev which decays by means of E2 radiation to the I = 0+ and 2+ members of the ground-state rotational band. In view of the recent results from internal conversion electron measurements at Rice University, the 613-kev γ ray was interpreted to be a transition from a 2+ β-vibrational state at 773 kev to the 4+ state at 163 kev. An interpretation of the observed γ-ray yields was carried out taking a γ-vibrational state at 790 kev and a β-vibrational state at 773 kev. The $B(E2)_d$ of the 2+ state at 50 kev in Th^{232} was about 150 times the single-particle estimate. The $B(E2)_d$ of the vibrational states in Th^{232} and U^{238} were between 2 and 4 times the single-particle estimate. Combining Bernstein's relative internal conversion electron yields with the γ-ray data, a value of $(8 \pm 2) \times 10^{-3}$ for the strength parameter ρ was obtained for the E0 transition between the 2+ state at 773 kev and the 2+ state at 50 kev in Th^{232}. (auth)

5712 MAGNETIC RESONANCE DETERMINATION OF THE NUCLEAR MOMENT OF TANTALUM-181 IN $KTaO_3$. Lawrence H. Bennett (National Bureau of Standards, Washington, D. C.) and J. I. Budnick. Phys. Rev. 120, 1812-15 (1960) Dec. 1.

The nuclear magnetic moment of Ta^{181} was found from the nuclear magnetic resonance of Ta^{181} in $KTaO_3$. The uncorrected value of the moment is 2.340 ± 0.001 nm. Consideration of diamagnetic shielding effects and a possible second order paramagnetic correction leads to the estimated value of $\mu = 2.35 \pm 0.01$ nm. (auth)

5713 DECAY OF Ag^{104} AND LEVELS IN Pd^{104}. H. Nutley and J. B. Gerhart (Univ. of Washington, Seattle). Phys. Rev. 120, 1815-18(1960) Dec. 1.

The radioactive decay of the isomers of Ag^{104} was investigated using scintillation spectrometers and a magnetic β-ray spectrometer. Half lives of (66 ± 1) and (29.8 ± 0.5) minutes were determined for the spin 5 and spin 2 isomers, respectively. Conversion electrons corresponding to 15 γ rays assigned to Pd^{104} were observed. Two allowed positron transitions were detected: one of end-point energy (990 ± 10) kev from the spin 5 isomer of Ag^{104}; and the other of end-point energy (2705 ± 15) kev from the spin 2 isomer. Gamma-gamma and β-γ coincidences were observed. The experimental data together with data obtained by other investigators were used to determine the spins and parities of the low-lying excited states of Pd^{104}. (auth)

5714 RADIOACTIVE DECAY OF Tm^{164} AND Tm^{162}. R. G. Wilson and M. L. Pool (Ohio State Univ., Columbus). Phys. Rev. 120, 1827-9(1960) Dec. 1.

Erbium oxide enriched to 35.1% and 14.1% in the mass numbers 164 and 162, respectively, were irradiated with 6-Mev protons. Activities decaying by electron capture with half lives of (2.04 ± 0.10) minutes and (77 ± 4) minutes were produced and were assigned to Tm^{164} and Tm^{162}, respectively, by the identification of the erbium K x ray, comparison with the activities produced by similar proton irradiations of each of the other enriched isotopes of erbium, and by the existence in the 2.04-minute activity of a prominent γ ray with the energy of the first excited level in Er^{164} determined from the decay of Ho^{164}. The γ-ray spectrum of Tm^{164} consists of only the erbium K x ray, a γ ray of 91 kev, and annihilation radiation; and that of Tm^{162}, of the erbium K x ray and γ rays of 102 and 236 kev. The three radiations observed in the decay of Tm^{162} are all in coincidence. Energy level schemes for the decay of these two new activities are proposed and branching ratios are estimated from relative intensities. (auth)

5715 GAMMA TRANSITIONS FOLLOWING THE DECAY OF NICKEL-65. R. Jambunathan, M. R. Gunye, and Babulal Saraf (Atomic Energy Establishment, Trombay, India). Phys. Rev. 120, 1839-42(1960) Dec. 1.

The γ transitions following the decay of 2.6-hr Ni^{65}, were studied by coincidence scintillation spectrometry. Gamma rays of energies 0.37, 0.51, 0.61, 0.77, 0.85, 0.95, 1.11, 1.48, 1.62, and 1.72 Mev having the intensity of 55, 1.5, 0.6, ~1, ~0.6, ~0.3, 140, 290, 10, and 6 per thousand disintegrations, respectively, are emitted in this decay. The gamma-gamma coincidence study is consistent with energy levels of Cu^{65} at 0.77, 1.11, 1.48, 1.62, and 1.72 Mev. The angular correlation of 0.37- and 1.11-Mev γ rays suggests the spin assignment of $^5/_2$ for the 1.11-Mev level and $^7/_2$ or $^3/_2$ for the 1.48-Mev level. Both the gamma transitions are mixtures of E2 and M1. (auth)

5716 RADIOACTIVE DECAY OF Lu^{171} AND LEVEL SCHEMES FOR Yb^{171} AND Yb^{169}. R. G. Wilson and M. L. Pool (Ohio State Univ., Columbus). Phys. Rev. 120, 1843-50(1960) Dec. 1.

Ytterbium oxide enriched to 93.8% in the mass number 171 was irradiated with 6-Mev protons. An activity decaying by electron capture with a half life of (8.28 ± 0.04) days was produced and its assignment to Lu^{171} confirmed by the identification of the ytterbium K x ray and by comparison with the activities produced by similar proton irradiations of each of the other enriched isotopes of ytterbium. The radiations observed in this activity were the L and K x rays of ytterbium and γ rays with energies of 72 to 76, 668 ± 7, 740 ± 3, and 841 ± 8 kev. Because neither particle nor annihilation radiation exists in this activity, the mode of decay is solely by electron capture to Yb^{171}. Gamma-gamma coincidence measurements were performed for the observed radiations. An energy level scheme was constructed for the decay of Lu^{171} using the results of the γ-γ coincidence measurements, an energy analysis of the conversion electron data, and calculations of transitions intensities for various trial multipole orders. Levels in Yb^{171} at 0 (1/2− [521]), 66.7 (3/2− 1/2), 75.9 (5/2− 1/2), 95.1 (7/2+ [633] $\tau > 10^{-6}$ sec), 122.4 (5/2− [512]), 167.3 (9/2+ 7/2), 208.1 (7/2− 5/2), 230.5 (7/2− 1/2), 246.5 (9/2− 1/2), 317.3 (9/2− 5/2), (350), 835 (7/2− [514]), 862 (possibly 5/2+ [642]), 935 (9/2+ [624]), and 949 (7/2) kev account for thirty of thirty-one transitions reported for this activity. Transition probabilities and branching ratios for the electron capture decay were calculated. Eighty-four per cent of the disintegrations of the 7/2+ [404] ground state of Lu^{171} occur to the 7/2− [514] state at 835 kev in Yb^{171}. The previously reported 600-day activity of Lu^{171} was not found. An energy level scheme for the decay of Lu^{169} (1.5 days) as reported by other workers is proposed with levels in Yb^{169} at 0 (7/2+ [633]), 24.2 (1/2− [521]), 70.9 (9/2+ 7/2), 87.0 (3/2− 1/2), 99.3 (5/2− 1/2), 161.7 (11/2+ 7/2), 191.4 (5/2−[512]), 244.0 (7/2− 1/2), 264.5 (9/2− 1/2), 278.7 (7/2− 5/2), 389.7 (9/2− 5/2), 523.1 (11/2− 5/2), 570.5 (5/2+ [642]), 648.2 (7/2− [514]), 962.2, 1451.6 (9/2+ [624]), 1456 (9/2), and 1465 (9/2) kev and with less certainty, at 488.9 (11/2− 1/2), 798, 870, 953, and 973 kev. This scheme accounts for 53 observed transitions following the decay of Lu^{169}. The ground state of Lu^{169} is probably the 9/2 [514] orbital also assigned to the ground state of Lu^{171}. This scheme is based upon an energy analysis of the reported transitions, intensity calculations for various trial multipole orders, and analogy with the scheme proposed for Yb^{171}. (auth)

5717 HIGH-ENERGY PION-NUCLEUS SCATTERING. Mirza A. Baqi Bég (Univ. of Birmingham, Eng.). Phys. Rev. 120, 1867-70(1960) Dec. 1.

It is suggested that an inconsistency in the customary treatment of Pauli principle effects is responsible for the discrepancy between the experimentally observed scattering cross sections of high-energy pions on nuclei and the values calculated from two-body amplitudes in the impulse approximation. The effect considered, and briefly discussed within the framework of a t-matrix theory, is the inverse eclipse effect noted by Glauber. Results are stated for the optical potential and the effective cross section and numerical values are quoted for negative pions on C^{12}. (auth)

5718 CHARGE DISTRIBUTION IN Be^9. Y. R. Waghmare (Physical Research Lab., Ahmedabad, India). Progr. Theoret. Phys. (Kyoto) 24, 681-3(1960) Sept. (In English)

Calculations were made for Be^9 electron scattering using the Fermi model. This nucleus is of interest since it is in the middle of the p-shell and a certain amount of quadrupole deformation of the nucleus is expected to appear. The results were found to be somewhat different from the results of Meyer-Berkhout, Ford, and Green for the parameters of Be^9. The value of the deformation parameter, E = 0.256, indicates quite a sizeable quadrupole deformation. It is considered that the Fermi charge distribution model including the effects of possible quadrupole deformation satisfactorily accounts for the observed Be^9 scattering cross section for 300-Mev electrons. (B.O.G.)

5719 THE PROBABILITY OF α BRANCHING FROM Ra^{225} INTO NEPTUNIUM SERIES. L. Z. Malkin, E. B. Nikol'skaya, and K. A. Petrzhak. Radiokhimiya 2, 632 (1960). (In Russian)

Studies were made of Ra^{225} α decay. Ra^{225} is a part of the neptunium series: $U^{233} \xrightarrow{\alpha} Th^{229} \xrightarrow{\alpha} Ra^{225} \xrightarrow{\beta^-} Ac^{225} \xrightarrow{\alpha} Fr^{221} \xrightarrow{\alpha} At^{217} \xrightarrow{\alpha} \ldots$ The maximum α branching in Ra^{225} was previously reported to be <0.01%. The obtained data suggest the maximum α branching is <0.0001%, which corresponds to $T_\alpha \geq 50{,}000$ years. (R.V.J.)

5720 ON THE INTERNUCLEON INTERACTIONS. V. V. Vanagas, J. (Yu.) A. Kalade, and V. K. Sugurovas (Shugurov) (Vil'nyus State Univ., [Lithuanian SSR] and Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian, SSR). Trudy Akad. Nauk Litovskoĭ S.S.R., Ser. B No. 3, 15-20(1960). (In Russian)

It is postulated that the space in nuclei has a constant negative curvature. The equation derived for the Yukawa potential is applied for describing deuterons. An attempt is made to explain the experimental magnitude of the nuclear force action radius by introducing non-Euclidean metrics. With certain postulations, the increase of the "meson mass' is inherently explained. (R.V.J.)

Particle Accelerators

5721 (MSUCP-6) SURVEY OF VARIATIONS IN ORBIT CHARACTERISTICS ARISING FROM AZIMUTHAL SHIFTING OF Cos θ FIELD COMPONENT IN A RESONANT EXTRACTION SYSTEM FOR A 3 SECTOR CYCLOTRON. H. G. Blosser and M. M. Gordon (Michigan State Univ., East Lansing). Nov. 1960. 19p. Contract AT(11-1)-872. OTS.

5722 (MURA-456) REMARKS ON THE DESIGN OF FFAG ACCELERATORS. F. T. Cole (Midwestern Universities Research Assn., Madison, Wis.). May 13, 1959. 26p. Contract AT(11-1)-384. OTS.

A review is given of the factors involved in the design of multi-bev proton FFAG accelerators, including magnet weights, equilibrium orbits, linear and nonlinear betatron oscillations, misalignments, and radio-frequency. The general features of radial and spiral sector accelerators which emerge from consideration of these factors are discussed. (auth)

5723 (JPRS-5903) THE FIRST LARGE CYCLOTRON IN POLAND. (Pierwszy Duzy Cyklotron' w Polsce). H. Niewodniczanski and J. Zakrzewski. Translated from Nukleonika 5, Suppl. 1, 3-24(1960). 28p. (OTS-60-41657). OTS.

A cyclotron with 120-cm-diameter electromagnet pole pieces that will accelerate deuterons to about 13 Mev is described. Other basic design data are given, and research programs planned and in progress are included. (J.R.D.)

5724 EXPERIMENTAL DETERMINATION OF THE POLE PROFILE OF A BETATRON MAGNET. Ladislav Sípek (Czechoslovak Academy of Science, Prague). Expti. Tech. Physik 8, 103-12(1960). (In German)

The measurement of the dependence of the field exponents of the magnetic field of a betatron for several parameters of the pole profile was described. The aim of the measurement was the establishment of an optimum profile, determination of the effect of individual parameters, and the definition of the effect of the production tolerances of the pole shoe on the exponent pattern. The measurement was carried out on magnets of the 15-Mev betatron by means of a special apparatus for direct measurement of the field exponents. (tr-auth)

5725 THE BEAM-PROGRAMMING SYSTEM OF THE BEVATRON. Harry G. Heard (Levinthal Electronic Products, Palo Alto, Calif.). IRE Trans. Nuclear Sci. NS-7, No. 4, 4-13(1960) Dec.

A brief description is given of the beam-programming equipment developed for the Bevatron. The system described provides analog-computer-controlled as well as beam-controlled frequency tracking. Equipment is described that permits arbitrary adjustment and control of the radial position of the circulating beam at any energy. Beam-intensity control and the automatic reduction of phase errors in the acceleration system are provided. Included also are units that produce long and short beam pulses. Equipment that permits highly multiple operation is also discussed. The integration of these equipments for extended injection is treated. (auth)

5726 MEASUREMENT OF SCATTERED NEUTRON RADIATION FROM A 35-MEV BETATRON. Wolfgang Pohlit (Max-Planck-Institut für Biophysik, Frankfurt am Main). Strahlentherapie 113, 469-74(1960) Nov. (In German)

In a 35-Mev betatron used for medical purposes, the distribution of slow neutrons was examined with indium foil. If the foils were laid during the radiation in small cylindrical paraffin moderators of approximately 6 cm wall thickness, the corresponding distribution of fast neutrons could be obtained. The neutron dose to the eyes was specially examined, and the importance of the single components of the unwanted radiation for the personnel and the patient was estimated. (auth)

Plasma Physics and Thermonuclear Processes

5727 (AFCRC-TN-60-185) INVESTIGATION OF MICROWAVE PROPERTIES OF PLASMAS. Scientific Report No. 7 [for] November 1, 1959 to January 31, 1960. Marvin Chodorow (Stanford Univ., Calif. Microwave Lab.). Feb. 1960. 24p. Contract AF19(604)-5226. (ML-697; AD-237450).

The steady state of plasma was studied, assuming thermodynamic equilibrium in a hot emitting enclosure. In studies on noise in plasma, an analysis of the two-frequency correlation measurement was made. Numerical solutions were computed for the determinantal equation for the interaction of a modulated electron beam with a plasma medium in an infinite magnetic field. Attempts to excite low-velocity plasma sound waves are described. An electrode configuration for imposing the r-f field on a plasma confirmed previous conclusions that confinement phenomena is a sheath effect. (For preceding period see ML-669.) (C.J.G.)

5728 (NP-9629) A SOLUTION FOR THE TWO-ELECTRON CORRELATION FUNCTION IN A PLASMA. B. D. Fried (Space Technology Labs., Inc. Physical Research Lab., Los Angeles) and H. W. Wyld, Jr. (Illinois. Univ., Urbana). Oct. 4, 1960. 32p. (STL/TR-60-0000-GR325).

The two-electron correlation function, g, responsible for "collisional" corrections to the correlationless (or Vlasov) description of a plasma, is investigated. It is shown that an exact solution of the integral equation for g can be found for a fairly wide class of spatially homogeneous, one-electron distribution functions, f, (the ion dynamics being neglected). This is carried out in detail for the simplest member of the class (the resonance shape), and the Landau damping of g to its asymptotic ($t \to \infty$) form is exhibited explicity. It is shown that correlations between particles separated by more than the Debye length are damped in a time which exceeds the period of plasma oscillations, ω_p^{-1}, and that these make an appreciable contribution to the "collisional" rate of change of f. It is concluded that for rapidly varying f (as in problems involving plasma oscillations) conventional treatments of the "collision" term should be replaced by a self-consistent solution of the coupled equations for f and g. (auth)

5729 (TID-11193) SOME MEASUREMENTS OF FLUCTUATIONS IN A PLASMA. F. W. Crawford and J. D. Lawson (Stanford Univ., Calif. Microwave Lab.). Oct. 1960. 27p. Contract AT(04-3)-326, Project Agreement No. 1. (ML-753). OTS.

Measurements of the fluctuations in anode voltage, tube current, and number density were made in a hot-cathode mercury-vapor discharge at a pressure of ~1μ, under both space-charge-limited and temperature-limited emission conditions. Substantial low-frequency fluctuations occur from zero to several hundred kc/sec with strong

components at ~60 and ~100 kc/sec. Potential distribution curves show noise generation over the first 20 cm of the plasma column. This is poorly correlated from point to point but appears to propagate in the electron thermal velocity range. Over the remaining 50 cm of the experimental tube, the signal is well-correlated and travels at $>10^9$ cm/sec. Despite the nonuniform noise distribution, the column appears as a uniform impedance (to external signals), and an approximate expression has been derived for its impedance/frequency characteristic. Number-density measurements, made by a microwave cavity perturbation technique, indicate fluctuations increasing in amplitude toward the cathode and persisting even when the discharge is temperature-limited and other fluctuations have been substantially reduced. (auth)

5730 (TID-11197) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 3 [for] June 1–August 31, 1960. (Stanford Univ., Calif. Microwave Lab.). Nov. 1960. 34p. Contract AT(04-3)-326. (ML-763). OTS.

It is noted that experiments involving plasmas are often complicated by instabilities in the discharge which may result in anode potential fluctuations. Work is in progress to determine the characteristics of this unwanted noise. During the report period impedance characteristics were examined in more detail to determine their relations with noise production. The construction of other plasma tubes designed to determine noise data under widely varying conditions is reported. In other work, the suppression of noise by the use of an axial magnetic field was investigated. A discussion of the wide variation in the noise spectra observed in the mercury vapor plasma tubes is included along with speculations concerning the basic noise-generation mechanism. Also included are equipment diagrams and figures in which data are presented. (J.R.D.)

5731 (UCRL-6078) FAST NEUTRAL PARTICLE INJECTION INTO A MIRROR MACHINE. Richard F. Post (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1960. 28p. Contract W-7405-eng-48. OTS.

Aspects of a method for creating and maintaining a hot plasma in a mirror machine by injecting fast atoms or neutral molecules are discussed. The general scheme is to create a well-collimated beam of energetic neutral particles, pass them across the magnetic field, and break them up as they pass through the confinement volume, thus providing a means for continuous reinjection of "hot" particles. Solutions to approximate differential equations for the plasma build-up are presented. (C.J.G.)

5732 (UCRL-6211) A BIBLIOGRAPHY OF LRL (BERKELEY AND LIVERMORE) UNCLASSIFIED REPORTS ON MAGNETOHYDRODYNAMICS AND PLASMA. Dorothy L. Gleichman, comp. (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 19[illegible]. 13p. Contract W-7405-eng-48. OTS.

A bibliography of 119 unclassified references on magnetohydrodynamics and plasma is presented. (J.R.D.)

5733 (AEC-tr-4183) MAGNETOACOUSTICS IN A THREE COMPONENT PLASMA. (Magnitnyi Zvuk v Trekhkomponentnoĭ Plazme). D. A. Frank-Kamenetskiĭ (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). Translation. 1960. 10p. OTS.

Also published in Zhur. Tekh. Fiz. 30, 893-8(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 26379.

5734 INSTABILITY OF CONDUCTING FLUID CYLINDER DUE TO AXIAL CURRENT. G. S. Murty (Royal Inst. of Tech., Stockholm). Arkiv Fysik 18, 241-50(1960). (In English)

The stability of an incompressible, inviscid, electrically conducting fluid cylinder in the presence of axial current is considered taking into account the effect of surface tension. The effect of gravity is taken into account approximately. The results are found to be in reasonable agreement with experiment. (auth)

5735 ENERGY BALANCE AND CONFINEMENT OF A MAGNETIZED PLASMA. B. Lehnert (Royal Inst. of Tech., Stockholm). Arkiv Fysik 18, 251-71(1960). (In English)

Under laboratory conditions particle losses from a magnetized plasma will produce a neutral particle flux reentering from the surrounding vessel walls into the plasma region. Even at very high temperatures, where the plasma is almost fully ionized, this gives rise to interactions between charged and neutral particles which cannot always be neglected. Three types of interactions are discussed: ionization, charge exchange, and elastic collisions with neutrals. The conservation laws of mass, charge, momentum, and energy are reconsidered for a two-fluid system with ionization, charge exchange, and elastic scattering of neutral particles taken into account. It is found not necessary to derive the energy equation in terms of the joint action of electromagnetic and mechanical changes of state. It has earlier been concluded from the motion of a single particle that a very strong confinement can be obtained in a rotating plasma situated in the magnetic field of a current loop (Bonnevier and Lehnert). These results are verified in a macroscopic theory including the energy balance of stationary motion. It is found that the main part of the heating of the plasma and the scattering of ions are not provided by coulomb collisions, but by collisions with reentering neutral particles. Two special cases are treated in detail, one with vanishing heat conductivity and one with infinite heat conductivity in the direction along the magnetic field. For the latter, which is more likely to occur in a high temperature plasma, the energy loss by escaping particles is deduced. The theory predicts that this loss should be several orders of magnitude less in the current loop configuration than in earlier described homopolar machines. Finally, some comments are given on the nonexistence of interchange instabilities in systems with volume currents. (auth)

5736 PROPAGATION OF ELECTROMAGNETIC WAVES ALONG A THIN PLASMA SHEET. James R. Wait (National Bureau of Standards, Boulder, Colo. and Technical Univ., Copenhagen). Can. J. Phys. 38, 1586-94(1960) Dec.

It is shown that a thin ionized sheet will support a trapped surface wave. The effect of a constant and uniform field is to modify the phase velocity and polarization of the surface wave. The essential features are illustrated by numerical results for selected values of the electron density, collision frequency, and gyro frequency. The effect of locating the plasma sheet near and parallel to a conducting plane is also considered. In this situation other modes of a waveguide type are possible in addition to the surface wave. (auth)

5737 AN INVESTIGATION OF THE TOROIDAL DISCHARGE IN A RAPIDLY VARYING LONGITUDINAL MAGNETIC FIELD. D. P. Ivanov and V. D. Kirillov. Doklady Akad. Nauk S.S.S.R. 133, 793-6(1960) Aug. 1. (In Russian)

A rapidly varying longitudinal field was used for confining, heating, and stabilizing a plasma. The plasma column resulting from a single longitudinal field was

studied in order to make a rough evaluation of the effects of field increase rate. In such a column plasma confinement is achieved by an azimuthal current I_φ which equalizes the pressure; the equilibrium can be produced by a one-direction field when the field inside the plasma column is nearly equal to that outside and the pressures of the fields are equal. Experiments were carried out in a 40-cm copper torus with a 16-cm cross section. The chamber consisted of 48 0.2-mm rings; chamber pressure was $\sim 1 \times 10^{-6}$ mm mercury. The deuteron and argon pressures varied from 0.004 to 0.02 mm mercury. The discharge current reached 50 ka for 250 μsec in a constant magnetic field up to 4000 gauss and in rapidly varying field up to ±6000 gauss. (R.V.J.)

5738 CHARGING OF HIGH-VOLTAGE CAPACITORS FOR THERMONUCLEAR RESEARCH. A. D. Appleton and G. F. O'Keefe (General Electric Co. Ltd., Wembley, Eng.). G.E.C. Atomic Energy Rev. 2, 183-91(1960).

Many experiments on controlled thermonuclear reactions require high-voltage capacitors to achieve a high rate of energy input to the apparatus. The General Electric Co. Ltd. of England has developed, specifically for this application, a capacitor charging unit that produces a constant charging current by the use of a saturable reactor. The equipment, the operation of which is described, is inherently safe against short circuits in the load and includes a feed-back control system to give optimum working conditions. Several capacitor banks can be charged to different voltages under fully automatic cyclic operation in a very stable manner. Some of the units of ratings up to 100 kv that have been supplied to the United Kingdom Atomic Energy Authority are illustrated. (auth)

5739 THE OAK RIDGE THERMONUCLEAR PROGRAM—RECENT ADVANCES ON THE DCX. J. L. Dunlap (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci. NS-7, No. 4, 19-25(1960) Dec.

In the Oak Ridge thermonuclear experiment, 600-kev molecular ions of hydrogen or deuterium are injected into the median plane of a direct current magnetic mirror machine (DCX). A fraction of the molecular ions is dissociated ($H_2^+ \rightarrow H^+ + H^0$) as the ion beam passes through a high-energy carbon arc whose electrodes are located at each end of DCX. The magnetic field configuration is such that the 300-kev atomic ions thus created are trapped by virtue of the change in charge-to-mass ratio and enter a circular orbit concentric with the magnetic axis. The neutral atoms and the remaining undissociated molecular beam leave the machine. Loss processes, principally charge exchange collisions suffered by the circulating ions, have thus far prevented achieving the appreciable plasma density required for observable fusion reactions. Plasma densities in the order of 10^{+10} ions/cm^3 and mean containment times of 10 to 12 msec were observed. The experimental program at the present time is one of diagnostic measurements on the trapped ions and their environment, and of building up the plasma density by increasing the trapping rate and containment time. (auth)

5740 ALKALI VAPOR PLASMAS. M. A. Hakeem and Harry S. Robertson (Univ. of Miami, Coral Gables, Fla.). J. Appl. Phys. 31, 2063-4(1960) Nov.

Alkali vapor positive columns, using cesium, potassium, and rubidium, were examined at a current range of 0 to 300 ma and pressures of ~0.01 to 2.0 mm Hg. At the lowest possible pressures and currents of 1 ma or less, very faint standing striations were sometimes seen with spacings of ~1 ma. At higher currents and pressures, these striations were not present. Cesium seems to be the most convenient alkali to use since it reaches an operable vapor pressure at a lower temperature than the others. (B.O.G.)

5741 PLASMA THERMIONIC CONVERTERS. E. W. Salmi (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc. 107, 1013-15(1960) Dec.

The use of cesium plasma for electric power generation is examined theoretically, and the calculations result in a current of 50 amp/cm^2, a voltage of 1.7 volts, and a power output of 80 watts/cm^2 for a cesium vapor pressure of 0.1 mm Hg at 2500°K. The plasma thermocouple experimental program and results in this field are described briefly; a triple-cell experimental rod was developed for testing in a reactor and consists of three cells stacked in series. A possible modification of this rod for use in mass quantity in a water tank reactor and future applications of thermionic converters are discussed. (D.L.C.)

5742 THEORY OF FUSION REACTIONS IN AN UNCONFINED PLASMA. J. G. Linhart (European Atomic Energy Community, Brussels). Nuovo cimento (10) 17, 850-63(1960) Sept. 16. (In English)

A criterion for a zero-energy gain fusion reactor is obtained, the reactor resembling a cylindrical H-bomb in which a plasma is either not confined or only marginally confined. A magnetically driven cylindrical plasma shell is shown to generate a plasma column for which the above-mentioned criterion could be satisfied. (auth)

5743 SPECTROSCOPIC STUDY OF HELIUM PLASMAS PRODUCED BY MAGNETICALLY DRIVEN SHOCK WAVES. E. A. McLean (U. S. Naval Research Lab., Washington, D. C.), C. E. Faneuff, A. C. Kolb, and H. R. Griem. Phys. Fluids 3, 843-56(1960) Nov.-Dec.

Measurements were made of the temperature, density, and degree of ionization of plasmas produced by Mach-30 magnetically-driven shock waves in helium (ambient pressure 1 mm Hg). Simultaneous photoelectric intensity measurements of the absolute spectral intensities of HeI λ3889, HeI λ5876, HeII λ4686, and HeII λ3203 indicate temperatures of 3.7 ev, electron and ion densities $\sim 10^{17}$ cm^{-3}, degree of ionization ~99.9%, and a density ratio of ~4 across the shock front. The estimated error is ±2% for the temperature and ±12% for the electron and ion densities. The electron density was derived independently from the width of HeII λ4686 and agreed with the photoelectric density measurement to within the experimental error for the line width, thus providing a proof of the ionization and excitation equilibrium assumption used in analyzing the absolute intensity data. Continuum intensity measurements provided a check on the consistency of the results. The temperature calculated from the measured shock velocity using the usual Rankine-Hugoniot equations is lower by a factor of about 2, and the density ratio is higher by a factor of about 3. A plausible explanation of this discrepancy is that ultraviolet radiation emitted by the hot plasma in the arc region is absorbed in front of the shock wave. (auth)

5744 ELECTRIC FIELD DISTRIBUTION IN A DENSE PLASMA. J. L. Jackson (National Bureau of Standards, Washington, D. C.). Phys. Fluids 3, 927-31(1960) Nov.-Dec.

A calculation is presented of the probability distribution function of the electric field at the center of an ion or atom in a plasma in the high ion density limit. In this limit, it is possible to consider rigorously the effect of the Coulomb interactions on the distribution function. The distri-

bution function in the high-density limit is Gaussian. The Coulomb interaction decreases the mean square electric field by the multiplicative factor $[1 + \kappa a_0 + \frac{1}{2}(\kappa a_0)^2]^{-1}$, where κ is the reciprocal Debye length and a_0 the radius of the ion or atom at whose center the field is evaluated. (auth)

5745 PLASMA ACCELERATION IN A RADIO-FREQUENCY FIELD GRADIENT. G. A. Swartz, T. T. Reboul, G. D. Gordon, and H. W. Lorber (Radio Corp. of America, Princeton, N. J.). Phys. Fluids 3, 973-6(1960) Nov.-Dec.

Experiments were performed at 140 Mc to determine the acceleration of a mercury plasma in an rf field gradient. With a maximum rf field amplitude of 170 v/cm, a tenuous plasma (of density less than a critical density) was accelerated from 5×10^5 to 25×10^5 cm/sec. A denser plasma (of density greater than the critical density) was decelerated in the same field. These experimental results are consistent with a theory based on energy considerations. (auth)

5746 SUFFICIENT CONDITIONS FOR HYDROMAGNETIC STABILITY OF A DIFFUSE LINEAR PINCH. Harold P. Furth (Univ. of California, Livermore). Phys. Fluids 3, 977-81(1960) Nov.-Dec. (UCRL-5865)

From the energy principle a sufficient stability condition can be derived that involves a disposable function. The existence of some choice of the disposable function such as to satisfy the sufficient condition is a necessary condition for stability. The disposable function may be chosen so as to yield sufficient conditions that are not necessary, but that may be useful from the points of view of simplicity and generality. This technique is illustrated for "maximal-force configurations," where the current density is everywhere orthogonal to the magnetic field. (auth)

5747 STABILIZATION OF PINCH DISCHARGES. Stirling A. Colgate and Harold P. Furth (Univ. of California, Livermore). Phys. Fluids 3, 982-1000(1960) Nov.-Dec. (UCRL-5862)

The hydromagnetic stability properties of "hard-core" pinches are shown to be more favorable than those of conventional "stabilized pinches." Linear "hard-core" pinch experiments with a wide range of configurations show a basic consistency with hydromagnetic theory, but all configurations studied so far become unstable at sufficiently high current densities and low particle densities, even if possessed of theoretical hydromagnetic stability. Pinches with nulls in B_θ tend to be much less stable than those with nulls in B_z. "Inverse stabilized pinches" yield perfectly reproducible magnetic probe traces at power levels several times those at which "stabilized pinches" are unstable. A technique for the study of plasma density distributions is given, based on the propagation of radial compressional waves. The theory of the steady-state pinch is enlarged to include convective effects and is documented by experiment. The role of electrodes is considered, and an anode-cathode asymmetry in instability behavior is demonstrated for the linear "stabilized pinch." The prospects of stable, high-temperature operation with the toroidal hard-core pinch, or "levitron," are discussed. (auth)

5748 KINEMATICS OF OHMIC HEATED PLASMAS IN THE B-1 STELLARATOR. W. Bernstein, A. Z. Kranz, and F. Tenney (Princeton Univ., N. J.). Phys. Fluids 3, 1019-25(1960) Nov.-Dec. (MATT-38)

A kinematic description of the B-1 stellarator plasma during various stages of Ohmic heating discharges is presented. It is shown that for specific ranges of plasma current, for a given confining field, the plasma assumes a shape which has an azimuthal distribution of the form exp im θ. It is further shown that the plasma column rotates at high velocity while the distortion is present. The possible relation between these current ranges and the predictions of hydromagnetic instability theory is considered. (auth)

5749 EFFECT OF MANY-BODY COLLISIONS ON THE RATE OF THERMONUCLEAR REACTIONS. Howard S. Taylor (Université Libre, Brussels). Phys. Fluids 3, 1032-3(1960) Nov.-Dec.

It has been shown that the rate of reaction of high-energy particles in a plasma forms the main contribution to the total thermonuclear reaction rate. Since collective phenomena also are associated with high-velocity particles, a question as to the relation between the two phenomena arose. The equation used in this study was first derived by Balescu and is developed through a series of limitations to the form: $-\frac{1}{2}(2/\pi)^{1/2}\ (\delta g/\delta x) = E\epsilon^3 x^2(\cos\theta)g$. This equation contains only binary collision as opposed to collective collision terms. Hence the rate of thermonuclear reaction is not affected by collective collisions in a deuterium plasma for which $\epsilon \approx \frac{1}{4}$ at a velocity region where $x = \epsilon^{-2}$. The fact that collective effects do not alter the tail of the distribution function in the region of interest does not exclude the possibility that collective effects might affect the reaction rate by requiring the use of a collision cross section. Such a cross section is derived on the basis of a potential of average force, accounting for collective effects from a fundamental point of view as opposed to the usual method of introducing collective effects into the cross section by using a Debye cutoff. (B.O.G.)

5750 PINCH WITH A SMALL ROTATION. Agnar Pytte (Princeton Univ., N. J.). Phys. Fluids 3, 1034-5 (1960) Nov.-Dec.

It has been shown that a small rotation destabilizes a marginally stable pinch when the centrifugal force is balanced by the pressure gradient alone, and by the Lorentz force alone. A derivation is given, beginning with a linearized equation of motion governing the displacement from equilibrium in an ideal hydromagnetic fluid, which points out that when both a material and a magnetic pressure gradient are present, and the trapped magnetic field decreases outward, the rotating equilibrium may be more stable than the static equilibrium. (B.O.G.)

5751 LOSS OF CHARGED PARTICLES DURING IONIZATION IN STELLARATOR DISCHARGES. W. Stodiek, R. A. Ellis, Jr., and J. G. Gorman (Princeton Univ., N. J.). Phys. Fluids 3, 1035-6(1960) Nov.-Dec.

It was previously shown that the confinement of plasma in Stellarators during the Ohmic heating process, after substantially full ionization is reached, is not in accord with classical collisional diffusion. Evidence is presented which shows that the enhanced diffusion rate also governs confinement during the ionization phase, where the neutral particle density is still high. The discharges considered were obtained with hydrogen in the B-3 Stellarator and were of the same character as those used to demonstrate the rapid loss of plasma after nearly full ionization. The peak electron density in each discharge is plotted as a function of the confining magnetic field for hydrogen pressures of 11.3×10^{-5}, 30×10^{-5}, and 58.1×10^{-5} mm Hg at applied electric fields of 0.031, 0.105, and 0.31 v/cm, respectively. It is concluded that there is some loss of plasma during the ionization phase of the discharges because the peak density becomes smaller as the confining field is reduced. The results are roughly consistent

with a time constant of the order of 100 μsec for diffusion across a magnetic field of 20 to 40 kilogauss, in general agreement with the times observed after peak density. (B.O.G.)

5752 ELECTRON DENSITY FLUCTUATIONS IN A PLASMA. E. E. Salpeter (Cornell Univ., Ithaca, N. Y.). Phys. Rev. 120, 1528-35(1960) Dec. 1.

The spatial Fourier transform ρ_{ke} for wave vector k of the charge distribution of the electrons was considered in a plasma with particle density n, electron and ion temperatures T and T_i, and Debye length D. The absence of a magnetic field, no collisions, and $nD^3 \gg 1$ were assumed. The statistical average of $|\rho_{ke}|^2$ was calculated as a function of $\alpha = 1/kD$ assuming complete thermodynamic equilibrium; that component of $|\rho_{ke}|^2$ which keeps in phase with the ion charge density fluctuations was also calculated. The frequency spectrum of the time-varying function ρ_{ke} was obtained at thermal equilibrium and simplified, assuming the ion mass to be much larger than the electron mass, for general values of α and T/T_i. For small α the main component of the spectrum had the characteristic Doppler broadening shape corresponding to the electron's thermal velocity. For large α a component with narrow width corresponding roughly to the ion velocity Doppler spread and very narrow side bands at plus and minus the frequency of electrostatic plasma oscillations was obtained. (auth)

5753 PLASMA ACCELERATION. Fourth Lockheed Symposium on Magnetohydrodynamics, December 2, 1959. Sidney W. Kash, ed. California, Stanford University Press, 1960. 122p. $4.25.

Nine papers are included which were presented at the Fourth Lockheed Symposium on Magnetohydrodynamics held in Palo Alto on Dec. 2, 1959. The emphasis is on the use of accelerated plasmas for propulsion for interplanetary travel. Some of the topics covered are acceleration by crossed electric and magnetic fields, scaling relations for plasma devices, and pulsed plasma accelerators. Seven of the papers are abstracted separately. (D.L.C.)

5754 THE USE OF PLASMA FOR PROPULSION OF INTERPLANETARY ROCKETS. Conrad L. Longmire (Los Alamos Scientific Lab., N. Mex.). p.3-11 of "Plasma Acceleration."

Plasma propulsion does not require high temperatures as do thermonuclear reactions and hence has a high probability of success, but only for enabling a rocket to escape from an orbit, not for blasting off from the surface of a planet or the moon. A total velocity change of at least 20 to 30 km/sec probably would be required from the plasma-thrust device to accomplish a reasonable interplanetary mission, and velocities of 100 km/sec have been obtained in plasma accelerators, but the power requirement puts an upper limit on the exhaust velocity. High specific powers of ≥1 watt/g can be obtained with a nuclear reactor. The problem of a low-temperature d-c plasma accelerator with the shape of a coaxial nozzle is treated in detail and applied to a rocket of mass 10^6 g and requiring an acceleration of 1 cm/sec^2. (D.L.C.)

5755 THE ELECTROMAGNETIC ACCELERATION OF A CONTINUOUSLY FLOWING PLASMA. B. Podolsky (Univ. of Cincinnati) and G. Borman. p.12-29 of "Plasma Acceleration."

A continuous stream gas produced in a steady-state crossed-field device by a time-independent $j \times B$ force is considered for some particular accelerator geometries. Three crossed-field solutions are presented, one for a one-dimensional flow with constant fluid properties and two for radial flow, one of the latter with variable (real gas) properties of lithium vapor. The problem of adverse currents produced by electromagnetic interactions is also considered. (D.L.C.)

5756 PLASMA PROPULSION BY MEANS OF A TRAVELING SINUSOIDAL MAGNETIC FIELD. Rudolf X. Meyer (Space Technology Lab., Inc., Los Angeles). p.37-46 of "Plasma Acceleration."

If electrodes are avoided in plasma propulsion devices due to rapid erosion, the magnetic fields propelling the plasma must be nonsteady, and analysis is carried out on a two-dimensional magnetic field which is sinusoidal and moving at a constant speed in a channel. Since the cyclotron frequency of the electrons in many cases is low compared with the collision frequency, one-fluid magnetohydrodynamic equations with scalar pressure and conductivity are used. The case for which the magnetic Reynolds number is zero is considered. A sample calculation is performed on hydrogen at 30,000°K which justifies the assumption of scalar conductivity. (D.L.C.)

5757 ACCELERATION OF METAL-DERIVED PLASMAS. W. L. Starr and J. T. Naff (Lockheed Aircraft Corp., [Palo Alto, Calif.]). p.47-59 of "Plasma Acceleration."

The impulse imparted to metal plasmas was measured for the following accelerator geometries: rectangular geometry (T-type electrodes) with exploding wires, rectangular geometry with electrode erosion, and coaxial geometry with and without erosion. The results are tabulated. Erosion appears to dominate in the coaxial geometry; only 5 to 10% of the injected mass contribute to the impulse. The effects of polarity in the coaxial geometry on the amount of erosion were studied, and, with the outer electrode as the cathode, the average luminous plasma velocity is estimated to be 7 cm/μsec, while with the inner electrode as the cathode it is estimated to be 9 cm/μsec; the impulse, however, is the same for both polarities. (D.L.C.)

5758 HYDROMAGNETIC PLASMA GUN. John Marshall (Los Alamos Scientific Lab., N. Mex.). p.60-72 of "Plasma Acceleration."

The design and performance of three hydrogen plasma guns developed for a controlled thermonuclear fusion project are discussed. Admission of gas was done by the impulsive method in which a hammer blow opens a valve. The diffusion of hydrogen through an evacuated 9.2-cm ID glass tube was followed with an ionization-gage probe. The first gun accelerated a large amount of plasma to $>10^7$ cm/sec and under certain conditions produced clean plasma with no electrode erosion. The second gun did not produce clean plasma until it was modified by installing a central electrode with an annular slot for gas admission. The discharge behavior inside the barrel of the modified gun was studied with magnetic probes. The guns were used to investigate the collision of two plasma clouds, and the momentum and energy of the plasma were determined. A Thomson mass spectrum of the plasma ejected by the modified second gun show traces of H^+, H^-, H_2^+, C^+, and F^-, the last two apparently formed a Teflon insulator in the gun. (D.L.C.)

5759 PROPULSION FROM PINCH COLLAPSE. S. Gartenhaus (Purdue Univ., Lafayette, Ind.) and L. M. Tannenwald. p.73-8 of "Plasma Acceleration."

The utilization of the pinch effect for producing a low-level thrust over a long period of time is considered theoretically for a device in which an axially symmetric

pair of electrodes sets up a discharge in a dilute preionized gas. Inter-particle collisions are ignored, and the plasma is treated as having a surface inside of which the electric and magnetic fields vanish. Equations of motion are derived for the pinch surface, and an equation is developed for the thrust, $T \sim I^2 N \nu t_c$, where I is the current, N is the number of electrode pairs, ν is the operating rate of a single pair of electrodes, and t_c is the collapse time of a single pinch. (D.L.C.)

5760 EFFICIENCY CONSIDERATIONS IN ELECTRICAL PROPULSION. Sidney W. Kash (Lockheed Aircraft Corp., [Palo Alto, Calif.]). p.79-93 of "Plasma Acceleration."

The efficiency of the pulsed plasma accelerator and the electrostatic ion accelerator is studied with emphasis on its variation with propellant velocity. General circuit equations are formulated for the plasma accelerator and applied to several cases, including one for which analytic solutions do not exist, and the effects of electric parameters on the performance are discussed. For the electrostatic ion accelerator, the effects of size, anode current density, and electric breakdowns on the power loss by thermal radiation are studied. (D.L.C.)

5761 METHOD AND APPARATUS FOR TRAPPING IONS IN A MAGNETIC FIELD. (to United States Atomic Energy Commission). British Patent 853,916. Nov. 9, 1960.

A method for injecting and trapping a continuous ion beam within a nonpulsed magnetic field is outlined in which molecular ions generated by an ion source are accelerated into a magnetic field at right angles and a high-intensity arc discharge is passed through the molecular ions to generate atomic ions which then pass into a trajectory of smaller radius. The molecular ions continue along their old path and are removed by collision, and the neutral particles pass out of the apparatus. This method may be useful in producing thermonuclear reactions in plasma. (D.L.C.)

Shielding

5762 (WADC-TR-59-772) THE TRANSMISSION MATRIX METHOD FOR PENETRATION PROBLEMS. Period covered: December 1958 through November 1959. David Yarmush, Julius Zell, and Raphael Aronson (TRG, Inc., Syosset, N. Y.). Aug. 1960. 299p. Project No. 7112. Contract AF33(616)-6081. OTS.

A practical machine method for computing transmission and reflection of radiation by laminated slab shields is described, making use of transmission and reflection matrices. These are combined in a way which produces a formal solution of the Boltzmann equation in slab geometry. This result is applied by using representations in terms of energy groups and angular expansions. Two codes for the IBM-704 which together carry out the computation of the transmission and reflection matrices are described and operating instructions are given. Numerical results for gamma rays are presented. The advantages of the transmission matrix method as compared to other methods are discussed. Appendices are included showing how in the P_1 approximation the method gives diffusion theory in a particularly simple way and how it can be applied to other geometries. (auth)

5763 IRON-ORE CONCRETE IN RADIATION PROTECTION. R. Thoraeus (Inst. of Radiophysics, Stockholm). Acta Radiol. 54, 410-16(1960) Nov. (In English)

The use of iron-ore concrete for the production of protective barriers against high-energy radiation is described. The ingredients and composition are specified and the conditions for the production of a high-grade material are discussed. The protective power of the material is studied on the basis of the attenuation properties and the broad-beam factor. (auth)

Theoretical Physics

5764 (JINR-E-507) ON THE RELATIVISTIC GENERAL THEORY OF REACTIONS. M. I. Shirokov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 12p.

Formulas of the relativistic general theory which express the cross section and the polarization in terms of phase shifts can be of different forms for different definitions of the relativistic spin operator. However, in the rest system of a particle, its spin operators coincide. This allows the general theory to be represented in a form that is the same for all equivalent definitions of the spin. (auth)

5765 DEVELOPMENT OF THE GRAND PARTITION FUNCTION FOR SYSTEMS OF IDENTICAL PARTICLES. M. Gaudin (Centre d'Études Nucléaires, Saclay, France). Nuclear Phys. 20, 513-32(1960) Nov. (3). (In French)

The perturbation expansion of the grand partition function is discussed. The general n^{th} order term is described by a pair of two permutations and its contribution is presented in a compact form of a sum of n^{th} order permanents. The procedure is applied to a system of fermions interacting via a two-body separable potential. The form of the series suggests a partial summation that gives the known result for the thermodynamic potential in the superconducting state. (auth)

5766 ON THE SUMMATION OF GENERALIZED LADDERS FOR A MANY-FERMION SYSTEM. M. L. Mehta (Centre d'Études Nucléaires, Saclay, France). Nuclear Phys. 20, 533-42(1960) Nov. (3). (In English)

The analogy between an interacting fermion system and a system in an external potential, which may be nonhermitian, is employed to show why the generalized ladder approximation for an interaction attractive near the Fermi surface diverges. (auth)

5767 EXPERIMENTAL TESTS OF CERTAIN HYPOTHESES REGARDING RELATIVE SYMMETRY IN STRONG INTERACTIONS. B. d'Espagnat, A. Martin, and J. Prentki (European Organization for Nuclear Research, Geneva). Nuclear Phys. 20, 543-56(1960) Nov. (3). (In French)

Various tests for the global symmetry and for the Salam-Polkinghorne assumption are proposed. In the high-energy reactions considered, such as antibaryon production, it is expected that the global symmetry might be more apparent than in reactions involving K mesons at low energies. Although the tests for the universality of the pion-hyperon coupling are described by equalities, those which apply to a comparison between the pion-hyperon and pion-nucleon couplings are expressed in terms of inequalities between cross sections for different processes. This is a consequence of indiscernibility and the presence of the target nucleon in the initial state. These inequalities might, however, prove to give rather simple tests as they hold independently of the number of emitted pions. The tests for the Salam-Polkinghorn assumption are chosen in order to give a lower limit on the number of Ξ's appearing in a reaction,

whereas the previously proposed tests gave an upper limit. Phase space effects are briefly discussed. (auth)

5768 THEORY OF PERTURBED MULTIPLE CORRELATIONS. Vincent Gillet (Centre d'Études Nucléaires, Saclay, France). Nuclear Phys. 20, 561-84(1960) Nov. (3). (In French)

Techniques using irreducible tensorial sets for the calculation of multiple correlated processes are extended to the case when the degeneracies of one or several component states are removed. The irreducible representation of an operator acting on a state perturbed through an interaction with a classical or quantal system is first given in a general form. The irreducible product of two operators is then easily generalized when one of the operators is acting on a space of nondegenerate states, the states of the tensor product space being nondegenerate also. This permits the construction of the most general density matrices for perturbed nuclear states prepared from perturbed states initially oriented through the absorption or the emission of a radiation of known polarization. Provisions are also made for taking into account any partial depolarization in external fields of the incident or emitted particles before absorption or detection. A detailed discussion is made of perturbed double and triple nuclear correlations, the polarizations of the nuclear states and of the absorbed (or emitted) radiations being specified (or analyzed) and the perturbing systems being oriented or not. For double angular distributions with axial measurements only, well known results are obtained. The infinite limit is discussed in detail. In particular, for nonoriented perturbing fields, the residual anisotropy, independent of the orientation of the observation plane (the "hard core" of double angular correlations) is calculated for triple correlation processes; it is shown to be a function of the multipolarities of the intermediate radiation, except in the case of axial perturbing fields. (auth)

5769 INVARIANCE AND THE S-MATRIX [PART] II. Y. Takahashi (Dublin Inst. for Advanced Studies). Nuclear Phys. 20, 621-9(1960) Nov. (3). (In English)

A formal method is proposed for handling an interaction, which is not invariant under a certain transformation. It is proved that a linearly dependent relation of the "invariance deficiencies" yields a selection rule for the S-matrix element constructed from the noninvariant interaction. (auth)

5770 VALIDITY OF THE TWO-PARTICLE APPROXIMATION IN THE MANY-BODY PROBLEM. Kailash Kumar (Tata Inst. of Fundamental Research, Bombay). Nuclear Phys. 21, 99-105(1960) Nov. (4). (In English)

Brenig's method in the many-body problem is shown to be equivalent to a method of superposition of configurations. Compact expressions are obtained for quantities neglected in the two-particle approximation. The magnitude of corrections to the energies is discussed. (auth)

5771 MASS DIFFERENCES IN SECOND ORDER PERTURBATION THEORY. A. I. Solomon (Peterhouse, Cambridge, Eng.). Nuclear Phys. 21, 161-3(1960) Nov. (4). (In English)

The results of numerical computations of the mass differences of certain elementary particles on the basis of second-order perturbation theory are given. The calculations are based on the assumption that the mass splitting is due to the mass differences of the intermediate particles emitted in the self-energy graphs. (auth)

5772 A SIMPLIFIED METHOD OF CALCULATION FOR THE RELATIVISTIC PROCESSES IN QUANTUM ELECTRODYNAMICS. P. Kessler (College de France, Paris). Nuovo cimento (10) 17, 809-29(1960) Sept. 16. (In French)

A simplified method of approximate calculation is proposed for relativistic processes in quantum electrodynamics. The starting point is a quantum field theoretical generalization of the semiclassical Williams-Weizsäcker method, which defines an equivalent photon spectrum for a relativistic charged particle. It is shown that a formula of the Williams-Weizsäcker type can be set up to express the probability associated with any elementary diagram containing two fermion lines and one photon line, provided that both fermion states are relativistic. The elementary virtual processes represented by these diagrams may thus be considered as quasi real processes. Several examples are given in which this concept is applied to calculate higher-order processes by relating them directly to simpler effects. The cases treated are (1) bremsstrahlung of a relativistic particle at a given angle; (2) nuclear recoil from pair creation by high-energy photons; (3) inner bremsstrahlung in the disintegration of the μ-meson; (4) radiative corrections in the compared β-ray spectra of B^{12} and N^{12}. Further possibilities to extend the method (especially to π-meson theory) are briefly discussed. (auth)

5773 LEE MODEL WITH SINGLE BOSON OSCILLATOR. G. Barton (Inst. for Advance Study, Princeton, N. J.). Nuovo cimento (10) 17, 864-75(1960) Sept. 16. (In English)

A Lee model with only one boson field oscillator is considered. The Heisenberg equations turn out to be linear, and the problem is soluble in all sectors. The spectrum is entirely and essentially discrete, and the physically interesting questions relate not to scattering but to straightforward energy measurements. In particular all the consequences of introducing an indefinite metric can be traced out explicitly; it appears that no consistent physical interpretation can be given. (auth)

5774 ON THE GAUGE PROPERTIES OF GREEN'S FUNCTIONS. I. Bialynicki-Birula (Univ. of Rochester, N. Y.). Nuovo cimento (10) 17, 951-5(1960) Sept. 16. (In English)

The transformation properties of Green's functions in quantum electrodynamics are derived by functional analysis. Also, the generalized Ward identities and branching equations are obtained from differential equations for the generating functional. (auth)

5775 SOME PROPERTIES OF SINGLE LOOP DIAGRAMS IN PERTURBATION THEORY. M. Fowler, P. V. Landshoff, and R. W. Lardner (St. John's Coll., Cambridge, Eng.). Nuovo cimento (10) 17, 956-63(1960) Sept. 16. (In English)

Some analytic properties of single loop diagrams are discussed, and in particular it is shown that it is not possible to set up a two-variable spectral representation for production processes. (auth)

5776 INCREASE IN THE INTENSITY OF COSMIC RADIATION ON MAY 4th, 1960. P. L. Marsden, J. B. Crowden, and C. J. Hatton (Univ. of Leeds, Eng.). Nuovo cimento (10) 17, 977-9(1960) Sept. 16. (In English)

The neutron intensity data recorded at Leeds during the solar injection of May 4, 1960, from 0300 to 2200 hr UT are plotted and the 1001- to 1216-hr portion compared with the neutron intensity increases reported from Deep River for the same day. The intensity rises correspond, indicating no delay between the times of arrival of the injected particles at these stations, but the Leeds data persisted in fluctuating above normal long after the Deep River data showed a smooth decrease. The points of similarity and

difference between this event and the 1956 event and its "diffuse phase" are discussed. (D.L.C.)

5777 THERMODYNAMICALLY EQUIVALENT HAMILTONIAN FOR SOME MANY-BODY PROBLEMS. G. Wentzel (Univ. of Chicago). Phys. Rev. 120, 1572-5 (1960) Dec. 1.

A method which allows a rigorous treatment of the statistical mechanics of a superconductor (Bardeen-Cooper-Schrieffer model) was generalized so as to be applicable to a wider class of many-fermion or many-boson systems. As an illustration, a degenerate boson gas was studied, adopting the "pair Hamiltonian" of Girardeau and Arnowitt. Their finding, for this model, that there is a "gap" in the energy spectrum of the lowest excitations was confirmed. (auth)

5778 UNIQUENESS PROPERTY OF THE TWOFOLD VACUUM EXPECTATION VALUE. Paul G. Federbush and Kenneth A. Johnson (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. 120, 1926(1960) Dec. 1.

It is shown under general assumptions that if the one-body Green's function equals its free-field value the theory is that of a free field. (auth)

5779 THE TREATMENT OF THE QUANTUM MECHANICAL MANY-BODY PROBLEMS WITH HELP OF MULTIPARTICLE FUNCTIONS. E. Kröner and F. Hofelich (Technische Hochschule, Stuttgart). Z. Physik 160, 297-309(1960) Oct. (In German)

The Bopp two-body treatment of the quantum mechanical many-body problem was generalized to a multiparticle model. Problems with N particles can be reduced approximately to those with L particles ($2 \leq L < N$). The greater the ratio L/N, the better the approximation in general. As an example it was shown that the state of the N electron atoms results approximately from that of the (N−1) electron atoms. If the lowest state is inferred for the experiment, the method can be tested. Adequate tabular values are found up to phosphorus (15 electrons). The ground state of the P atoms calculated semitheoretically agrees within 1% with the experimental value. This can be regarded as proof for the utility of the method and as experimental confirmation of the (unrelativistic) multielectron Schrödinger equation. The application of the method to molecular and crystal problems and eventually to nuclear problems appears possible. (tr-auth)

REACTOR TECHNOLOGY

General and Miscellaneous

5780 (AAEC/E-49) THE DOPPLER COEFFICIENT FOR REACTORS CONTAINING THORIUM. A. Keane (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales), M. H. McKay, and B. E. Clancy (New South Wales, Australia. Univ., Kensington). Oct. 1959. Reprinted June 1960. 14p.

The Doppler increase in the effective resonance integral was calculated for a model absorber that approximates the resonance structure of Th^{232}. The results indicate that for rods of pure thorium the increase depends approximately on the square root of the temperature, and very good agreement is obtained with experimental values of (1/I)(dI/dT). The calculations also show that the addition of scattering material to the fuel rods will lessen the temperature dependence of the increase in the effective resonance integral. (auth)

5781 (ANL-6136) WATER CHEMISTRY AND FUEL ELEMENT SCALE IN EBWR. C. R. Breden, I. Charak, and R. H. Leyse (Argonne National Lab., Ill.). Nov. 1960. 105p. Contract W-31-109-eng-38. OTS.

The first two sections summarize investigations in EBWR concerned with some aspects of water chemistry. The results of many of these investigations have not been previously published in a form given wide distribution. Included are studies of water conditions, corrosion products (composition, activities, transportation, deposition, and distribution), water dissociation, water activity, fission-product release, and build-up of plant activity. The last two sections of the report give the results of studies of the heat-transfer characteristics of fuel-element scale and effects of high-temperature heating on scale removal and fuel-element growth. The maximum scale thickness measured was about 0.008 in. Heat-transfer calculations based on scale thermal conductivity measurements indicate the possibility of maximum fuel temperatures as high at 1692°F at 100-Mw operation of the core. This temperature is in a range where fuel growth, with resulting fuel element distortion and damage, is expected. Observed trends that may alleviate damage are the tendency of scale to flake off in high-heat transfer areas and the restraining effect of cladding on growth of fuel. No satisfactory means has been found to descale the fuel plates. (auth)

5782 (ARF-4132-14) STUDIES OF REACTOR CONTAINMENT. Summary Report No. 3 [for] February 1, 1960 to July 31, 1960. T. A. Zaker, ed. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Aug. 1960. 88p. Contract AT(11-1)-528. OTS.

Work on design procedures for blast shields had as its objective the development of methods of analysis of wave motion in one-dimensional systems composed of crushable material subjected to prescribed loadings at a free surface. The objective of the shock crushing of reactor shield materials task was to establish the loci of pressure-specific volume states attained by shock compression curves in the pressure-specific volume plane traced by porous solids in the crushed state. The explosive decompression of water resulting from pressure vessel rupture is being studied by determination of nature and magnitude of transient pressure loading in and on reactor vessels. Explosives test evaluation of blast shields and blast shield materials is being made for nuclear reactors. In the design of external containment structures investigation was made of the behavior of rigid-capped cylinders subjected to internal static pressure loading. (For preceding period see ARF-4132-13.) (W.L.H.)

5783 (CF-60-1-65) DEPENDENCE OF CORE POWER DENSITY ON REACTOR PARAMETERS IN A GAS-COOLED REACTOR. Necati Ozisik and R. B. Korsmeyer (Oak Ridge National Lab., Tenn.). Jan. 27, 1960. 28p. OTS.

As previously shown, the influences of various key parameters on the reactor average core power density of gas-cooled reactors are not easily seen from inspection of general analytic equations because of the interdependence of many variables. A method is presented by which the analytical expression is reduced to a simple, approximate relation expressing the core power density as a function of independent key parameters of limited range. Only three numbers need be determined empirically, essentially from the fuel and channel geometry, to obtain numerical exponents for the entire power density equation in independent form. The exponents in the independent equation are evaluated for the case of clad, multi-rod cluster fuel assemblies in circular channels. (auth)

5784 (CF-60-11-113) ANALOG SIMULATION OF HRP IN-PILE SLURRY LOOP FACILITY IN THE LITR. D. B. Hinton (Oak Ridge National Lab., Tenn.). Nov. 28, 1960. 24p. OTS.

An analog simulation was made of the HRP in-pile slurry loop in the Low Intensity Training Reactor. The radiolytic gas pressure in the pressurizer was determined. This pressure is a result of the generation of radiolytic gas in the loop core. A graphical result was obtained showing the effect of catalyst activity and pressurizer flow rate on the pressure rise from radiolytic gas. The thermal behavior of the system was studied, and the response to various controller settings was predicted. Controller settings very near optimum for the actual process were recommended from the analog study. (auth)

5785 (CF-60-12-18) A TRANSPORT CALCULATION OF THE HFIR BEAM HOLE CURRENTS. H. C. Claiborne and G. Rakavy (Oak Ridge National Lab., Tenn.). Dec. 5, 1960. 13p. OTS.

An estimate was made of the beam hole currents to be expected from both the radial and tangential beam holes in the present ORNL High Flux Isotope Reactor design. The angular fluxes required for these calculations were determined by an 18-group, S_8 transport calculation (SNG reactor code). Both type beam holes produced thermal neutron currents of 7.5×10^{10} neutrons/cm^2/sec at a power level of 100 Mw. The nonthermal component of the beam current was 7.0×10^{10} and 4.5×10^{10} neutrons/cm^2/sec for the radial and tangential holes, respectively. (auth)

5786 (CWAED-42) PASSAGE OF THERMAL NEUTRONS THROUGH A HOT SLAB OF MODERATING MATERIAL. C. M. Carley (Canadian Westinghouse Co., Ltd. Atomic Energy Div., Hamilton, Ont.). Sept. 1960. 27p. (AECL-1082). AECL.

The effect of scattering collisions on the distributions in speed and direction of thermal neutrons passing through a thin slab of moderating material is studied. The slab is assumed to be composed of a noncapturing monatomic gas, and it is further assumed that no neutron undergoes more than one collision in the slab. Equations are derived and evaluated for the angular current density and the speed distribution of the spatial density of neutrons emerging from one side of the slab when thermal neutrons impinge on the other side with an arbitrary current density. A P_2 approximation is used for the scattering kernel. In the cases studied, variations are made in the arbitrary incurrent and in the thickness of the slab and its temperature and the mass of its atoms. The results show that passage through the slab has very little effect on the distribution of the neutron's directions. The distribution of their speeds is changed very little in form; but, when the slab is hot, the distribution is shifted toward higher speeds. The results indicate that the concept of effective neutron temperature can be applied to the neutrons leaving the slab. A curve is obtained showing the effect of the temperature of the slab on the effective temperature of the neutrons emerging from it. (auth)

5787 (DTMB-1450) MULTIGROUP TRANSPORT CODE RDR 5. Charles Dawson (David Taylor Model Basin. Applied Mathematics Lab., Carderrock, Md.). Dec. 1960. 25p.

RDR 5 is a multigroup, slab-geometry neutron transport code for the NORC computer. With features such as anisotropic scattering, as many as 99 lethargy groups, and a 10-point discrete ordinate approximation to the angular dependence of the vector flux, the code can provide solutions with considerable accuracy. The equations used in the code are derived, and the input for the code is described. The results obtained with different approximations that may be used in RDR 5 are compared. (auth)

5788 (HW-48116) DESIGN CRITERIA FOR PRT REACTOR—PRTR FUEL ELEMENT EXAMINATION FACILITY. W. S. Kelly (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 9, 1958. 13p. OTS.

The PRTR Fuel Element Examination Facility will be an air-cooled pit located in the floor of the reactor hall. The facility will be used for examination of fuel elements and process tubes irradiated in the PRTR. Equipment will be provided to optically view, photograph, and measure the fuel elements and process tubes. Handling equipment will be provided to manipulate the assemblies past the viewers and facilitate the handling of disassembled components of suitably designed elements. Cooling equipment will be provided to prevent overheating of the elements. The anticipated examination rate is one element per week, based on the forecasted rate of discharge of elements from the reactor. (W.L.H.)

5789 (HW-58357) FINAL REPORT, DESIGN TEST PR-32. TEST OF RUPTURE PRESSURE OF PRTR BIOLOGICAL SHIELD MOAT RUPTURE DIAPHRAGMS. P. M. Jackson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 3, 1958. 10p. OTS.

The procedure used and results obtained from testing the pressure rupture membrane, which provides a release mechanism for excessive pressure that may develop if a large leak occurs in the upper piping space of the biological shield, are described. (J.R.D.)

5790 (NAA-SR-Memo-5543) INERTIAL PRESSURE CALCULATIONS FOR KEWB. C. Warner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 17, 1960. 20p. OTS.

Inertial pressure of the KEWB (Reactor Safety Experiments) is calculated assuming that the inertial pressure rise is attributable to fission-nucleated bubbles. (C.J.G.)

5791 (NDA-14-82) DOPPLER TEMPERATURE COEFFICIENTS OF REACTIVITY IN FAST REACTORS. H. Yamauchi and J. De Felice (Nuclear Development Associates, Inc., White Plains, N. Y.). June 17, 1955. 40p. For Atomic Power Development Associates, Inc.

Formulas and data required for calculating temperature coefficients of reactivity due to the Doppler effect are given. The results of coefficient calculations for the APDA reference design, the EBR, and an ANL critical assembly are reported. (auth)

5792 (NDA-2134-1) A SURVEY OF FAST REACTOR SAFETY PROBLEMS. P. Mittelman and M. Silberstein (Nuclear Development Corp. of America, White Plains, N. Y.). Mar. 29, 1960. 18p. Contract AT(30-1)-2303. OTS.

One of the major considerations facing the future development and practical application of fast reactors is the successful solution of the safety problems associated with this type of reactor. A survey of fast reactor fundamental safety problems was conducted at Atomic Power Development Associates, ANL, NRTS, and LASL. Problems that were felt to require additional effort are summarized. (W.D.M.)

5793 (RAG-14) LE DÉPOUILLEMENT DES MESURES DANS LE CAS DE L'EXPÉRIENCE EXPONEN-

TIELLE. (Analysis of Measurements in the Case of Exponential Experiments). J. Patry (Reaktor A. G. Würenlingen, Switzerland). Apr. 1960. 29p.

Analysis of the results of neutron flux $\phi(\gamma,z)$ studies in exponential experiments using a Zuse Z22 electronic calculator is described. This calculator has an 8192-word memory drum and a rate of 16 numerical operations per second. The radial distribution $\phi(\gamma)$ is studied by calculating the ratio $\phi(\gamma)/J_0(\mu\gamma)$, which allows good results if the flux distribution involves only a few harmonics. For the analysis of axial distribution, $\phi(z)$ three methods are used: the first considers rough measurements and determines the ratio $\phi(z \pm \Delta Z)/\phi(z)$ eliminating values exceeding the average previously calculated; in the second method a first approximation to the logarithmic decrement is introduced in such a way that the correction can be quickly executed; the third method is based on the ratio $\phi(H-z)/\sinh(\gamma H-\gamma z)$ and gives the value as a function of depth H-z starting at the surface. (T.R.H.)

5794 THE STATIC HYDRAULIC STABILITY OF BOILING WATER REACTORS. H. Kornbichler (AEG-Kernenergieanlagen, Frankfurt am Main). Atomkernenergie 5, 397-400(1960) Nov. (In German)

Under unfavorable conditions, a flow of subcooled water that is brought to boiling in a heated channel can have a pressure drop characteristic which—instead of increasing monotonically—rises to a maximum, and then declines. Operation of the channel under conditions that pertain in the neighborhood of such a maximum will give rise to static instabilities, since here different flow rates can produce the same pressure drop. This fact is well known from forced circulation boilers. It is demonstrated in a general way that those static instabilities can never occur in a boiling water reactor. (auth)

5795 CALCULATION OF THE LINEAR EXTRAPOLATION LENGTH AT THE SURFACE OF AN ARRANGEMENT OF AN INFINITE PLATE WITH "CAN" ON BOTH SIDES. M. Angelopoulos (Greek Public Power Corp., Athens). Atomkernenergie 5, 401-6(1960) Nov. (In German)

The method given in a previous paper (Atomkernenergie 5, 217(1960)), dealing with the calculation of the linear extrapolation length on the surface of an infinite plate surrounded by moderator is extended for the case of an infinite plate with can on both sides. The problem is formulated using the multiple-collision method for the plate and can, and a P_{2N-1}-approximation for the surrounding moderator. Numerical results are evaluated, assuming elementary diffusion theory (P_1-approximation) for the moderator. The limiting case, where both media (plate and can) are identical, is discussed with special reference to previous papers. (auth)

5796 NUMERICAL APPROXIMATION METHOD FOR THE CALCULATION OF IRREGULARLY ERECTED REACTOR LATTICES WITH ONE OR MORE NEUTRON GROUPS. H. Borgwaldt and H. Harder (Deutsche Babcockwerke, Oberhausen, Ger.). Atomkernenergie 5, 406-12(1960) Nov. (In German)

The real lattices of heterogeneous reactors are never quite regular. Upon subdividing the reactor in geometrically equal cells we will find different types of cells. From this it follows that the condition grad $\Phi = 0$ does not apply to the microscopic flux distribution on every cell boundary. In order to be able to treat such systems with one or more neutron groups we derive approximate relations between the neutron sources inside a lattice cell, the unidirectional currents j_m of neutrons streaming into the cell through each of its sides, and the unidirectional currents j_n of neutrons streaming out. Multiplying systems are discussed in connection with the corresponding two group-relations. Possible applications of these relations are evaluations of macroscopic flux distributions in complex lattices, of control rod worths, of flux distributions inside selected cells (e.g., hot spots), and of averaged lattice parameters to be used in simplified (homogenized) reactor calculations. (auth)

5797 THE PROSPECTS FOR NUCLEAR PROCESS HEAT. James H. Wright and David R. Smith (Westinghouse Electric Corp., Pittsburgh). Chem. Eng. 67, No. 24, 123-8(1960) Nov. 28.

Nuclear systems for electric power generation have been under investigation for some time and are definitely economical at present in certain areas and when in extremely large sizes. There are a number of nuclear systems available for applications for process heat, each with its own advantages and disadvantages. A discussion is given of the economic and technical feasibility of nuclear heat. Considering all U. S. industries, the breakdown in energy input is ~80% for process heat and 20% for electricity. More than one-third of the process heat consumed by process industries is low-pressure steam, a product that could be supplied by present-day nuclear steam plants. Low cost fuel is the main economic attraction of nuclear heat. Comparative costs of a fuel cycle for low- and high-temperature reactors are tabulated. A description is given of the preferred reactor system (PWR) for process heating. The reactor safety aspects of the PWR system are discussed. From the economic standpoint, it seems that nuclear process heat plants are already competitive with conventional plants under the proper set of conditions. (B.O.G.)

5798 A REACTOR SAFETY SYSTEM USING TRANSISTORS AND SILICON CONTROLLED RECTIFIERS. William M. Trenholme (General Electric Co., West Lynn, Mass.). IRE Trans. Nuclear Sci. NS-7, No. 4, 14-19(1960) Dec.

An all-semiconductor reactor safety system is described which consists of a d-c amplifier, an adjustable trip level bistable circuit, a diode logic circuit, and a power switching circuit. The d-c amplifier is a simple emitter follower transistor stage. Three transistors are used in the bistable circuit, two in a Schmitt-trigger arrangement and one as an output drive. The diode logic circuit uses a combination of OR and AND gates to give 2-out-of-3 coincidence of the bistable circuit outputs. A unijunction transistor and two silicon-controlled rectifiers are the active elements in the power switching circuit. These components are particularly well suited for the on-off control needed in reactors and the circuitry is reasonably fail-safe. (auth)

5799 TRENDS IN NUCLEAR REACTOR CONTROL. W. C. Lipinski and J. M. Harrer (Argonne National Lab., Ill.). IRE Trans. Nuclear Sci. NS-7, No. 4, 25-32(1960) Dec.

Some trends in reactor control system design are discussed and criticized. The items treated are control mechanisms, control systems, and supervisory circuits for both research and power reactors, and some of the trends outlined are (1) safety and control rod combinations even for large reactors, (2) free-falling rods, (3) gravity-accelerated, rotary-seal rack and pinion drives for water reactors, (4) coincidence circuits for flux trips in power reactors, and (5) use of period meters during the start-up phase. It is concluded that control rod drive design is

simple and reliable, while there is an undesirable trend toward greater complexity in control circuit design. (D.L.C.)

5800 INTEGRAL REACTOR THEORY: ORTHOGONALITY AND IMPORTANCE. M. A. Robkin and M. Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Nuclear Sci. and Eng. 8, 437-42(1960) Nov.

It is observed that the formal mathematical adjoint of the integral form of the solution of the Boltzmann equation is not the same as, and is not a solution for, the formal mathematical adjoint to the integro-differential form. If the concept of importance is to have a unique physical meaning, there must be a basic physical difference between the adjoint integral and the integral solution to the integro-differential equation. It is shown that such a physical difference can be specified, that the concept of "inverse causality" is unnecessary, and that normal "forward" causality is sufficient to derive the importance from first principles. The resulting equations for the importance distributions are then shown to be completely consistent with all requirements of orthogonality between these distributions and the neutron distributions. (auth)

5801 THE MEASUREMENT OF REACTIVITY. Cesar A. Sastre (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng. 8, 443-7(1960) Nov. (BNL-4935).

The use of a general purpose analog computer for the continuous measurement of reactivity of a nuclear reactor is described. The machine is programmed to solve the conventional space-independent reactor kinetics equations for reactivity using the signal from an ion chamber as input data. This technique provides reactivity information instantaneously and continuously. Using it, one can calibrate control rods "on the run," and can measure stationary values of reactivity without waiting for asymptotic periods to develop. (auth)

5802 SOME SERIES OCCURRING IN THE THEORY OF THE SQUARE LATTICE CELL. D. C. Leslie (United Kingdom Atomic Energy Authority, Winfrith, Dorset, Eng.). Nuclear Sci. and Eng. 8, 451-2(1960) Nov.

Calculations have been made previously of the flux and thermal utilization in a square lattice cell. This work is of continuing interest because of its close connection with the Fainberg–Galanin theory of finite heterogeneous lattices. Cohen evaluated sums of the form: $C_k = \Sigma_{n=1}^{\infty} n^{2k-1}$ (coth $\pi n - 1$), for odd values of k by comparing expressions for the flux in polar and Cartesian coordinates. It is shown that $C_1 = \Sigma_{n=1}^{\infty} n$ (coth $n\pi - 1$) can be evaluated by normal processes of analysis, and that the results agree with those of Cohen. The method should generalize to other values of k. (B.O.G.)

5803 THE RADIOCHEMICAL DETERMINATION OF URANIUM BURNUP. Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). p.3-8 of "Materials in Nuclear Applications. ASTM Special Technical Publication No. 276." Philadelphia, American Society for Testing Materials, 1960.

Techniques used in determining uranium burnup are reviewed briefly under the headings of indirect methods (neutron flux and produced power measurement) and direct methods (uranium isotopic composition and individual fission product analysis), and the radiochemical method using Cs^{137} and its disadvantages are described in detail. A summary of the present state-of-art of uranium burnup determination and of current efforts to improve this state is included. (D.L.C.)

5804 SHIELD DESIGN FOR SNAP REACTORS. V. Keshishian (Atomics International, Canoga Park, Calif.). Paper No. 1334-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 14p.

Studies of the SNAP reactors showed that, depending on vehicle, component, and shielding arrangement, shield weights can vary from zero to a few thousand pounds. Since the SNAP reactors are very small in size, it was found to be advantageous to place all of the shield around the reactor to achieve a minimum system weight. To show the effect of vehicle layout on shield weight, a variety of cases was considered. Lithium hydride was assumed to be the shielding material in each case. Figures illustrating the various configurations are included. (M.C.G.)

5805 APPARATUS FOR POSITIONING NEUTRON-ABSORBING MATERIAL WITHIN A NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 849,716. Sept. 28, 1960.

An apparatus for positioning a neutron-absorbing material, particularly a safety member for terminating a chain reaction, in a reactor is designed so that it does not depend on gravitational forces and can be operated in a relatively small space adjacent to the reactor. The apparatus comprises a frame, a rotatable shaft and drum mounted on the frame, a magnetic clutch engagement with the drum, and a flat spring which is wound at one end on the drum and which has a plate of neutron-absorbing material attached to its other end. In operation, the magnetic clutch prevents the spring from unwinding and is de-energized only when it is desired to release the spring into the reactor. The arrangement of the apparatus for lowering and raising a control member smoothly is also described. (D.L.C.)

5806 MOTOR DRIVEN SCREW AND NUT MECHANISM FOR MOVING A PUSH ROD. (to United States Atomic Energy Commission). British Patent 851,925. Oct. 19, 1960.

A drive mechanism for moving reactor control rods is invented which may be used in a relatively small space, thus enabling control rods to be located in adjacent reactor channels, and which provides a great speed reduction in the conversion of rotary motion into linear motion. The mechanism comprises a drive screw rigidly coupled to a push rod and a motor for causing the screw to move the push rod. One embodiment of the invention and its dimensions and performance are described. (D.L.C.)

5807 IMPROVEMENTS IN NUCLEAR REACTOR FUEL ELEMENT HANDLING PLANT. Richard Arthur Taylor (to Babcock & Wilcox Ltd.). British Patent 852,513. Oct. 26, 1960.

A plant for handling radioactive reactor fuel elements for storage in a pond which has a skip hoist for transporting the fuel element coffin between a first station above the pond level and a second station within the pond is described. Means are provided for securing the coffin lid at the first station and removing it below the pond level just before the coffin arrives at the second station, the removal being effected by projections in the pond which intercept the lid. (D.L.C.)

5808 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Derek Randall Smith, Alan Frederick Edward Wise, and Geoffrey John Bealey (A.E.I. John Thompson Nuclear Energy Co., Ltd.). British Patent 852,682. Oct. 26, 1960.

A reactor fuel element is designed with fins extending helically around the element and with turbulators in the form of strips, plates, studs, and/or wires extending either longitudinally or radially around the element, or both. This arrangement gives maximum contact between the coolant and the heat transfer surface. (D.L.C.)

5809 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Barry Edward Eltham and Gwillym John Blockley (to United Kingdom Atomic Energy Authority). British Patent 852,685. Oct. 26, 1960.

A high-pressure gas-cooled, D_2O-moderated reactor is designed in which a thick stainless steel pressure vessel for D_2O containment is lined with a graphite neutron reflector covered with an aluminum membrane to prevent D_2O-graphite contact. In this way, the moderator can be pressurized by contact with coolant gas to eliminate the pressure differential on the coolant tubes and to enable operation at 150°C without neutron loss due to absorption in the pressure vessel walls. The pressure differential across the pressure vessel is eliminated by connection to the coolant gas circuit. (D.L.C.)

5810 IMPROVEMENTS IN OR RELATING TO HEAT TRANSFER SYSTEMS. Arthur James Brown (to United Kingdom Atomic Energy Authority). British Patent 853,511. Nov. 9, 1960.

A reactor fuel element is designed as a rod with helical fins along its surface and of a pitch on the order of 20 rod diameters to ensure effective heat transfer. A drawing of one configuration and its dimensions are presented for an air-cooled, graphite-moderated reactor with horizontal cooling channels of pentagonal-shaped cross section so arranged that the fuel rods rest on two inclined faces. (D.L.C.)

Power Reactors

5811 (CVNA-68) CAROLINAS-VIRGINIA TUBE REACTOR HEAVY WATER LEAK DETECTION TECHNIQUE AND DEVELOPMENT. ANALYSIS AND DESCRIPTION. A. Andonedis and R. A. Wiesemann (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). June 1960. 60p. For Carolinas Virginia Nuclear Power Associates, Inc. OTS.

An investigation was made to determine the suitability of various instruments for detecting leakage of primary coolant heavy water into secondary system light water. It was found that the infrared spectrometer is the most practical instrument to use for continuous on-stream monitoring because it has good sensitivity and precision and because it is a rugged device suitable for plant installation. The capabilities of other instruments for this application are also discussed. Equations are developed for correlating primary coolant leak rate with the fluid system parameters and measurable properties of the primary and secondary system such as heavy-water isotopic concentration and radioactivity. (auth)

5812 (DEG-Inf. Ser.-242) BIBLIOGRAPHY ON NUCLEAR PROPULSION FOR SHIPS. B. Yates, comp. (United Kingdom Atomic Energy Authority. Development and Engineering Group. Library and Information Dept., Risley, Lancs, England). 1960. 147p. BIS.

Revision of IGRL-IB/R-24.

A bibliography containing 1158 references is presented on the economics, design, operation, performance, and safety of gas- and steam-cooled, organic-moderated, boiling-water, pressurized-water, and sodium-cooled reactors for use in nuclear ship propulsion. (C.J.G.)

5813 (DP-545) HEAVY MODERATED POWER REACTORS. Progress Report [for] September 1960. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Dec. 1960. 18p. Contract AT(07-2)-1. OTS.

At the end of Sept. 1960, construction of the Heavy Water Components Test Reactor (HWCTR) was 41% complete. Hydraulic tests of one of the two main D_2O pumps for the facility were concluded satisfactorily. Extrusion billet designs that appear to afford satisfactory control of cladding thickness have been devised at Nuclear Metals, Inc., for both sizes of uranium metal tube desired for HWCTR irradiation tests. The first 10-ft-long fuel tube of compacted uranium oxide in Zircaloy was fabricated at the Savannah River Laboratory by a combination of vibratory compaction and swaging. The average oxide density in this tube was 91.8% of theoretical. (For preceding period see DP-535.) (auth)

5814 (NAA-SR-Memo-3295(Rev.)) DESIGN AND PERFORMANCE OF INDUCTION PUMP FOR SRE MODERATOR SYSTEM. R. S. Baker (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 20, 1958. 32p. OTS.

A three-phase linear induction pump was designed, constructed, and installed in the Sodium Reactor Experiment to control moderator temperature. A maximum flow rate of 91 gpm was obtained at 760°F, at 12.4 psi, and an efficiency of 1.7%. (C.J.G.)

5815 (NP-9115) APPLICATION OF PHILADELPHIA ELECTRIC COMPANY FOR CONSTRUCTION PERMIT AND CLASS 104 LICENSE. PEACH BOTTOM ATOMIC POWER STATION. PART A. GENERAL INFORMATION. PART B. PRELIMINARY HAZARDS SUMMARY REPORT. VOLUME I. PLANT DESCRIPTION AND SAFEGUARDS ANALYSIS. VOLUME II. SITE AND ENVIRONMENTAL INFORMATION. (Philadelphia Electric Co.). July 1960. 435p. OTS.

The reactor system is of the solid fuel homogeneous type, employing graphite as moderator and helium as coolant. The fuel and fertile material (Th^{232}) are in the form of carbides dispersed in the moderator. The design outlet gas temperature from the reactor will be 1380°F at 350 psia with steam conditions of 1000°F at 1450 psi. The plant will produce 40 Mw(e). The nuclear steam supply system, conventional equipment, containment, plant operation, radioactive effluents, and safety analysis are discussed. Radioactive inventories, site description, meteorology, hydrology, and geology are given. (W.D.M.)

5816 (NP-9333(Vol.IV)(Paper 2)) AIRBORNE ELECTRONICS FOR NUCLEAR POWERED VEHICLES. J. W. McNabb and P. P. Sondeen (Bendix Aviation Corp. Bendix Systems Div., Ann Arbor, Mich.). Paper 2 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 20p.

Problems in fabrication, testing, and evaluation of electronic components for nuclear-powered aircraft are discussed. An evaluation of the program of designing and selecting electronic components for the mission and traffic control subsystem is made. (C.J.G.)

5817 (NP-9340(Vols. I-IV)) ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS, ORGANIZED BY THE NETHERLANDS'-NORWEGIAN REACTOR SCHOOL AT INSTITUTT FOR ATOMENERGI, KJELLER, NORWAY, 22nd AUGUST–3rd SEPTEMBER, 1960. VOLUMES I–IV. (Netherlands-Norwegian Reactor School. Advanced Summer Inst., Kjeller, Norway). 1960. 4½ in. thick.

A series of lectures on fuel elements for water-cooled power reactors are presented. Topics covered include fabrication, properties, cladding, radiation damage, design, cycling, storage and transport, and reprocessing. Separate abstracts were prepared for the twenty-two lectures. (W.D.M.)

5818 (NP-9340(Vol. I)(Sect. I)) HISTORY AND CURRENT STATUS OF FUEL ELEMENTS FOR POWER REACTORS. T. J. Barendregt (Norway. Institutt for Atomenergi, Kjeller). Section I of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 12p.

The advantages and disadvantages of water-cooled power reactors are enumerated, and a brief history of reactor development is outlined. Classification of fuel elements, requirements for nuclear fuel, present status, burn-up, cladding, heat transfer, and reprocessing are discussed. (W.D.M.)

5819 (NP-9340(Vol. II)(Sect. I)) DESIGN OF FUEL ELEMENTS. Birger Kierulf (Norway. Institutt for Atomenergi, Kjeller). Section I of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 34p.

Design of fuel elements is defined as transferring nuclear and technical data concerning fuel, canning, elongations, and coolant to an economic design acceptable for production. A summary of normalized power generation cost for several types of reactors of 75-, 200-, and 300-Mw(e) capacity is given, and a comparison is made with conventional coal-fired plants of the same size. Data on pressurized and boiling, light- and heavy-water power reactors are given. The different items comprising a complete fuel element are discussed in terms of fuel cladding, stiffeners, end connections, design trends, etc. (W.D.M.)

5820 (NP-9340(Vol. II)(Sect. II)) SPIKED FUEL ELEMENTS FOR HBWR. Steinar Aas (Norway. Institutt for Atomenergi, Kjeller). Section II of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 14p.

The excess reactivity of the initial charge in HBWR was not sufficient to take the reactor up to the specified temperature limit, i.e., 150°C bulk water temperature. It became necessary to spike the first charge with a number of elements fueled with 1.5% enriched material in the form of UO_2. In order to reduce the amount of stainless steel and to cut down fabrication cost to a minimum, a design based on single tubes, uncompartmented, was decided on. The design is described in detail. (W.D.M.)

5821 (NP-9340(Vol. II)(Sect. III)) SECOND FUEL CHARGE OF THE HALDEN BOILING WATER REACTOR. J. H. Mogard (Aktiebolaget Atomenergi, Stockholm). Section III of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 23p.

Some features of the fuel-element design and the fabrication of the second fuel charge for the Halden Boiling Water Reactor are described. Comments are made on the expected in-pile performance in the light of specified operation conditions for the fuel elements. The fuel consists of 1.5% enriched UO_2 in the form of 12.54-mm-diameter pellets enclosed in Zircaloy-2. (W.D.M.)

5822 (NP-9340(Vol. II)(Sect. IV)) FUEL CYCLING IN POWER REACTORS. V. O. Eriksen (Norway. Institutt for Atomenergi, Kjeller). Section IV of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 21p.

A brief account is given of some physics aspects of fuel recycling in power reactors. The physics parameters describing the build-up of heavy isotopes and the burn-up of fissionable materials are treated. The factors influencing the neutron balance in a reactor system, and which ultimately define the lifetime of the fuel, are illustrated. (W.D.M.)

5823 (NP-9340(Vol. II)(Sect. V)) TRANSPORT OF IRRADIATED FUEL ELEMENTS. R. Rometsch (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Section V of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 20p.

Some of the problems encountered in the normal transportation of irradiated power reactor fuels are outlined. Three principal conditions for the transport of these fuels are to provide for adequate radiation shielding; to allow for sufficient heat dissipation so that the elements stay at a temperature not affecting their mechanical stability; and to avoid any conditions resulting in any neutron chain reaction. Regulations established by the IAEA and the USAEC are discussed. (W.D.M.)

5824 (NP-9340(Vol. II)(Sect. VI)) STORAGE AND MECHANICAL HANDLING OF NUCLEAR FUEL ELEMENTS. R. Rometsch (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Section VI of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 25p.

Handling, storage, and processing of irradiated fuel elements at a chemical reprocessing plant are treated. Cask testing and unloading, intermediate storage, mechanical preparation, mechanical decanning, chopping and leaching, and dissolver loading are discussed in detail. (W.D.M.)

5825 (NP-9340(Vol. IV)(Sect. II)) A CONSIDERATION OF FUEL CYCLES. John H. Schraidt and Richard C. Vogel (Argonne National Lab., Ill.). Section II of ADVANCED COURSE ON FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. 71p.

The optimization of fuel cycle costs requires the consideration of various reactor variables such as the achievable burn-up, specific power, thermal efficiency, load factor, and the degree of enrichment of the fuel. There are also various important factors in the net fuel cost such as fabrication, inventory, reprocessing, fuel transportation charges, and credit for fissionable material produced. Various steps in two types of fuel cycles and the current research directed at improvement of these various steps are discussed. (W.D.M.)

5826 (SRO-39) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT [FOR] NOVEMBER 1960. (Savannah River Operations Office, AEC). 22p. OTS.

A summation of development activities on various heavy-water power reactors under AEC contract is presented. Components development for various critical and subcritical facilities is discussed. The design, cost, and construction-time estimates, and results of tests on components of the Savannah River Components Test Reactor are presented. The status of programs on beryllium development, and cladding and fuel-element fabrication is presented. (W.L.H.)

5827 SELECTION OF MATERIALS OF CONSTRUCTION FOR REACTOR PRESSURE CIRCUITS. A. Prince. G.E.C. Atomic Energy Rev. 2, 205-9(1960).

A discussion is given of the properties necessary for

steels used in the construction of reactor pressure vessels, gas ducts, and steam-raising units for gas-cooled power reactors. All present requirements are met by normal carbon manganese steels, but special attention has to be paid to the possibility of brittle fracture. The selection of plate, the choice of operating conditions, and the need to change these conditions over the life of the reactor, are discussed. Details are given of the methods of quality control used for plate, forgings, and welding electrodes. (auth)

5828 TESTING OF O-RING SEALS FOR REACTOR PRESSURE CIRCUITS. R. L. Page. G.E.C. Atomic Energy Rev. 2, 210-15(1960).

The applications, problems, and supply of static O-ring seals are discussed, together with the method and apparatus used to investigate specific properties of the rings. Indications are that silicone-rubber rings are quite satisfactory for sealing CO_2 at pressures to 150 lb/in.^{2}g (10.5 kg/cm^2) and at temperatures to 150°C, providing the correct ring and groove are used in any particular application. Leakage of CO_2 is mainly by diffusion through the ring. (auth)

5829 THE STRESS-RELIEF OF STEAM-RAISING-UNIT VESSELS AT HUNTERSTON. S. Clinton and G. W. Laing. G.E.C. Atomic Energy Rev. 2, 216-23(1960).

A survey is given of methods available for the stress-relief of large welded steel vessels, followed by a description of the equipment and procedure adopted for stress-relieving the sixteen steam-raising-unit vessels for Hunterston Nuclear Generating Station. The operation conforms to B.S. 1500:1958, and takes about 50 hr. An oil-fired furnace is used to produce hot air, which is directed to the inside of the suitably lagged vessel and distributed by means of vents and baffles. Readings of temperature distributions and variations over the cycle are presented for one of the units treated. (auth)

5830 VACUUM TESTING OF TUBE ELEMENTS FOR STEAM-RAISING UNITS. M. S. Hayward. G.E.C. Atomic Energy Rev. 2, 224-8(1960).

The application of a high-vacuum leak-detection technique to the routine works testing of tube elements for steam-raising units is discussed. The installation used for testing the tubes for Hunterston Nuclear Generating Station is described, and an indication of its performance is given. A Pirani gauge used in conjunction with a cooled charcoal trap acts as a detector for the probe gas, which is hydrogen. The minimum leak that it is necessary to detect is 2×10^{-6} liter torr/second. (auth)

5831 NUCLEAR POWER FOR SHIP PROPULSION. J. E. Richards (British Shipbuilding Research Assn., [London]). J. Brit. Nuclear Energy Conf. 5, 227-39(1960) Oct.

A short appraisal is given of the present position regarding the possible application of nuclear power to merchant-ship propulsion. The type of ship under consideration for the first application of nuclear power is the large oil tanker, and types of slightly enriched uranium reactor which are being studied are reviewed and economic factors are discussed. More detailed consideration is given to nuclear fuel and fuel cycles, and particular attention is directed toward the possible use of civil plutonium as a fuel for merchant ships. The characteristics of this fuel are discussed and some preliminary results are presented of an investigation being made by the British Shipbuilding Research Association (B.S.R.A.) Atomic Energy Team at Harwell into a plutonium-burning fuel cycle. The results of the B.S.R.A. study illustrate the need for intensive research and development on plutonium-fueled systems. (auth)

5832 NUCLEAR ROCKET MISSIONS AND ASSOCIATED POWER PLANTS. John J. Newgard and Myron M. Levoy (Thiokol Chemical Corp., Denville, N. J.). p.445-57 of "Proceedings of the Xth International Astronautical Congress, London, 1959." Vienna, Springer-Verlag, 1960. (In English)

The power plant requirements for a number of terrestrial escape to orbit and space missions utilizing open cycle nuclear power plants are presented. Among the missions analyzed are single-stage, large payload, nuclear boosted, and escape vehicles; chemically boosted, second-stage nuclear rockets escaping with large payloads, and terrestrial orbiting nuclear vehicles capable of moving into far space to perform such missions as orbiting Mars. A "family" of hydrogen-cooled, solid-fuel graphite element, graphite core moderated, BeO reflector moderated reactor power plants is analyzed. The general reactor system structure under diverse size and power conditions but similar for all "family" members is presented. Such power plant considerations as heat transfer, fluid flow, nuclear statics, and power plant dynamics utilizing reflector control are considered. Principal problem areas, such as core corrosion-erosion, reactor start-up, and possible power plant perturbations leading to accidents are discussed. It is shown that a basic consistent philosophy of nuclear rocket flight utilizing the power plants discussed may be developed. (auth)

5833 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. (to Societe Francaise des Constructions Babcock & Wilcox). British Patent 847,984. Sept. 14, 1960.

A heat-exchange system for nuclear power stations with gaseous coolants which enables the heat-exchanging surfaces to be reduced by using as the coolant a gas undergoing an endothermic reaction at the hot end and an exothermic reaction at the cool end is described. For example, PCl_5 may be used as a coolant between a 310°C hot source and a 130°C cold source because it undergoes endothermic dissociation to PCl_3 and Cl_2 at 310°C and then reassociation at 130°C with a heat evolution of 30 kcal. (D.L.C.)

5834 IMPROVEMENTS IN OR RELATING TO GAS COOLED POWER REACTORS. George Edward Lockett (to United Kingdom Atomic Energy Authority). British Patent 852,206. Oct. 26, 1960.

A jacking device is described for releasing the pressure exerted by the reflector on the core of a gas-cooled power reactor presented in Patent Application No. 36774/56 in which the elements are pivotally supported at their lower ends. In this way, the reactor may be readied for loading or unloading operations, and a grapple is described for withdrawing elements from the core for a reactor with coolant flow holes between adjacent elements as in Patent Application No. 36775/56. (D.L.C.)

5835 IMPROVEMENTS IN BOILING REACTORS. (to General Electric Co.). British Patent 852,293. Oct. 26, 1960.

A self-regulating boiling reactor for power generation is designed so that improved performance and enhanced overall breeding ratios result. In this reactor, the boiling region (upper part of the reactor) has a positive void coefficient of reactivity at start-up temperatures and high reactivity at operating temperatures which give an increased steam output, while the nonboiling region has a negative void coefficient of reactivity which prevents run-

away of the reactor. These conditions are obtained by having a high moderating coolant-to-fuel ratio in the boiling region and a low ratio in the nonboiling region. The design features of the reactor and its operation in a power generation system are discussed. (D.L.C.)

5836 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. William Allan Russell (to Hawker Siddeley Nuclear Power Co., Ltd.). British Patent 854,144. Nov. 16, 1960.

A reactor suitable for use in marine propulsion is designed in which the core is supported at the bottom and top by conical rings abutting conical faces on the core and secured so that they are free to move vertically but not radially. In operation, loads on the core due to ship rolling or pitching are carried to the pressure vessel walls without retarding differential thermal expansion. (D.L.C.)

Research Reactors

5837 (AERE-R-3155) PHYSICS MEASUREMENTS DURING THE COMMISSIONING OF PLUTO. APPROACH TO CRITICALITY AND LOADING TO FULL CORE. C. J. England and S. B. Wright (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 30p. BIS.

A brief description of the PLUTO Reactor is given with emphasis placed on safety circuits and instrumentation. Procedures used in the safe loading of fuel for the first criticality are listed. The first fully loaded core is described. (C.J.G.)

5838 (CNC-36) SUI PARAMETRI NUCLEARI DI UN REATTORE TIPO TRIGA E SUL COEFFICIENTE DI TEMPERATURA DI "SPEEDING-UP." (Nuclear Parameters of a TRIGA Reactor and Speeding-up Temperature Coefficient). L. Di Palo and G. Focaccia (Italy. Comitato Nazionale per le Ricerche Nucleari. Divisione Studi e Ricerche, Rome). Sept. 1960. 92p.

The influence of zirconium hydride on the mean values of the nuclear constants of a TRIGA reactor was evaluated according to the theory of the isotropic oscillator model. This evaluation, covering the cross sections that do not follow the 1/v law, led to the determination of corrective (not 1/v) factors, referred to a constant spectral distribution in the 0 to 0.13 ev energy region. Temperature influence on nuclear constants, due to the "speeding-up" phenomenon, was evaluated together with the connected reactivity coefficient. This required the determination of the transport cross section of the hydrogen in the hydride as a function of neutron energy, taking also in consideration an elastic scattering in the 0.13 to 0.26 ev energy region. The influence of cooling water on neutron thermalization was neglected. Mean values of the constants were determined independently of experimental data, considering a step variation both for the nuclear constants in the fast region and for the slowing down neutron spectrum, instead of a continuous variation, as a function of energy. The results were compared with the data used by General Atomics for the criticality calculations of the TRIGA prototype. (auth)

5839 (NP-9333(Vol.II)(Paper 2)) NEUTRON AND GAMMA FLUX MAPPING AT THE RADIATION EFFECTS FACILITY. R. L. Gamble, J. K. Grant, H. H. Nichols, R. M. Thornton, and J. H. Wilson (Lockheed Nuclear Products, Marietta, Ga.). Paper 2 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 27p.

The slow neutron flux per watt of reactor power, fast neutron dose rate per watt, and γ dose rate per watt were measured in the irradiation volumes around the Radiation Effects Reactor for six shield configurations. Radiation dose as a function of distance from the reactor is presented in graphical form. (C.J.G.)

5840 (NP-9333(Vol.III)(Paper 4)) RADIATION EFFECTS OF A 10-MW REACTOR ON ENVIRONS OF AFP 67. J. M. Selby, C. A. Willis, B. M. Bowen, and J. H. Edgerton (Lockheed Nuclear Products, Marietta, Ga.). Paper 4 of FOURTH RADIATION EFFECTS SYMPOSIUM, SEPTEMBER 15-16, 1959, CINCINNATI, OHIO. GENERAL SESSION PAPERS. 25p.

An analysis of the environs of the Radiation Effects Reactor for radiation and activation effects on soil, air, and water was given. Preliminary results from instrument surveys, foil measurements, and studies of γ and neutron exposures on plant life are reported. (C.J.G.)

5841 (NP-9374) OPERATION OF THE MIT RESEARCH REACTOR AT POWER LEVELS UP TO TWO MEGAWATTS. D. D. Lanning and P. Steranka (Massachusetts Inst. of Tech., Cambridge). Oct. 7, 1960. Includes "Application for an Amendment to License R-37," dated Oct. 7, 1960. 47p. OTS.

Operation data at 1 Mw are presented for the MIT Research Reactor for parameters that will be affected by a rise in power level to 2 Mw. It is shown that the reactor with its present cooling system can be operated safely at 1 to 2 Mw without the fuel plate surface reaching the D_2O boiling point if the reactor is provided with a D_2O high-temperature scram set for 55°C and a D_2O low-flow scram set for 750 gpm. The effects of power levels up to 2 Mw on the emergency conditions that were previously worked out for 1 Mw operation are considered. (C.J.G.)

5842 (NP-9603) PTR CRITICAL EXPERIMENT—HAZARD SUMMARY REPORT. (AMF Atomics, Inc., Greenwich, Conn.). Nov. 10, 1960. 71p. OTS.

Authorization and approval are requested to use the facilities of the IRL Reactor to perform the Pressure Tube Reactor (PTR) critical experiment. The design and scope of the PTR critical experiment are described, and potential hazards are discussed. The PTR consists of 3.51-in.-diameter cylindrical fuel elements located on a $3\frac{1}{2}$ in. triangular pitch. The experiment would be performed by replacing the IRL core with a PTR core and utilizing the existing IRL control drive mechanisms, control system, and monitoring system. The core materials and core size for the PTR are typical of a pool type research reactor. (W.D.M.)

5843 ACTIVATION ANALYSIS OF WATER OF THE POOL REACTOR OF THE ATOMIC ENERGY INSTITUTE. Fausto W. Lima, Alcidio Abrão, and Constancia Pagano (Universidade, São Paulo, Brazil). Anais assoc. brasil. quim. 18, 211-22(1959). (In Portuguese). (IEA-19)

The principles and importance of the method of activation analyses are described. The use of an "internal standard" to avoid neutron shadowing is shown. The results for the analyses of sodium in the water of the swimming pool of the Institute of Atomic Energy reactor and in graphite, uranium, and gold in ores are presented; the amounts of this element in the material analyzed are of the order of parts per million. The chemical procedures used in each case are described. (auth)

5844 THE PETTEN HIGH FLUX REACTOR. J. H. B. Madsen and J. Coehoorn (Reactor Centrum Nederland, [Brussels]). Atoomenergie 2, 156-61(1960) Oct. (In Dutch)

The details and results of the start-up experiment of the Petten High-flux Reactor are reported. The reactor went critical on Sept. 28, 1960. (J.S.R.)

5845 DESIGN AND APPLICATIONS OF THE "CONSORT II" REACTOR. K. Hart. G.E.C. Atomic Energy Rev. 2, 192-9(1960).

Following an outline of the fields of use of research reactors in universities and similar institutions, the design of the 100-kw Consort II reactor is discussed, with particular reference to the differences between it and the earlier Consort I. The reactor uses standard fuel plates of slightly enriched uranium alloy, with water as moderator and coolant, and gives a thermal-neutron flux at the edge of the tank of 3×10^{11} n/cm^{2}s. The main parameters are tabulated, and the illustrations include drawings of the reactor arrangement and the internal layout of the tank. Brief details are given of some of the experiments that can be carried out with the reactor, and a table is given of representative short-half-life radioisotopes that can be produced. (auth)

5846 INVESTIGATIONS ON RADIOLYTICAL DECOMPOSITION OF WATER IN THE PRIMARY COOLING CIRCUIT OF THE NUCLEAR REACTOR "EWA." Andrzej Kostyrko (Inst. of Nuclear Research, Warsaw). Nukleonika 5, 133-42(1960). (In Polish)

Some definitions and notions concerning the radiolytic processes in water and their role in nuclear reactors were discussed. Data of H_2 yields removed in the deaerator of the nuclear reactor "EWA" are presented. The H_2 measurements with the thermoconductometric analyzer were done. The results show that H_2 yields are relatively small. Diagrams are presented for relationships between H_2 yields and reactor's power supply, as well as water and air flowrates through the deaerator. Some conclusions referring to suitableness of the deaerator's application are presented. (auth)

5847 NORWAY BUILDS WORLD'S FIRST BOILING HEAVY WATER REACTOR. Etienne J. Guerin. Research/Develop. 11, No. 12, 56-60(1960) Dec.

The boiling heavy water reactor that went critical recently at Halden, Norway, is described. This reactor will be jointly operated by scientists of 14 nations for the first three years and will later serve to produce steam for a paper mill. The output will be 15 tons of steam per hour. The reactor vessel has room for 320 fuel elements. Using fuel elements of natural uranium at first, a temperature of 302°F is anticipated. For the second charge, enriched uranium will be used for some of the elements, increasing the temperature to 446°F. Final temperature with further enrichment will be 482°F. About 16 tons of heavy water is used in the reactor core. (M.C.G.)

5848 FUEL ELEMENTS FOR THERMAL-FISSION NUCLEAR REACTORS. Oliver Flint (to United Kingdom Atomic Energy Authority). British Patent 854,122. Nov. 16, 1960.

Reactor fuel spheres suitable for use in thermal reactors such as those described in Patent Serial No. 848,901 may be fabricated comprising a moderator core, an electrically conducting outer face, and a coating of fissile material. The core may be made from beryllia, magnesia, and alumina, while the outer face may be graphite or a metal, e.g., copper, silver, or nickel. Four examples of preferred fabrication in the above way are included. (D.L.C.)

WASTE DISPOSAL AND PROCESSING

5849 (CF-60-10-43) REMOVAL OF STRONTIUM FROM WASTES. T. Tamura and E. G. Struxness (Oak Ridge National Lab., Tenn.). Nov. 28, 1960. 19p. OTS.

Results of a study of several natural phosphatic minerals which appear promising for applications in waste disposal and the use of aluminum phosphate for removal of strontium in a conventional water treatment process are described. Tests of a waste-treatment system employing phosphated wastes are also included. (J.R.D.)

5850 (NYO-2577) ULTRASONIC LEACHING OF SIMULATED CALCINED WASTES. (Aeroprojects, Inc., West Chester, Penna.). Aug. 1960. 30p. Contract AT(30-1)-1836. OTS.

The effectiveness of ultrasonic and nonultrasonic methods of leaching calcined wastes is compared. In general, ultrasonic excitation was effective in reducing both the volume of liquid and the time necessary to leach the isotopes completely from calcined wastes in both batch and continuous-flow ultrasonic treatment vessels. Approximately 95 to 100% of cesium was leached in 24 to 30 hr with continuous ultrasonic activation. The most effective treatment was found to be with a cavity coupler system. (C.J.G.)